The Welding Engineer

Edited by L. B. Mackenzie

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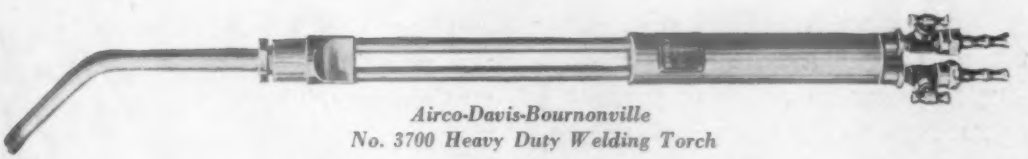

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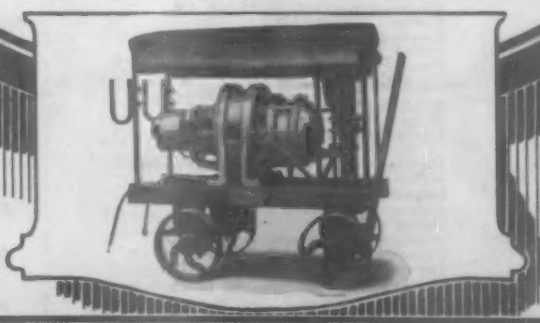

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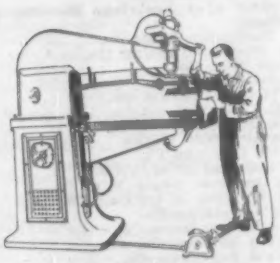

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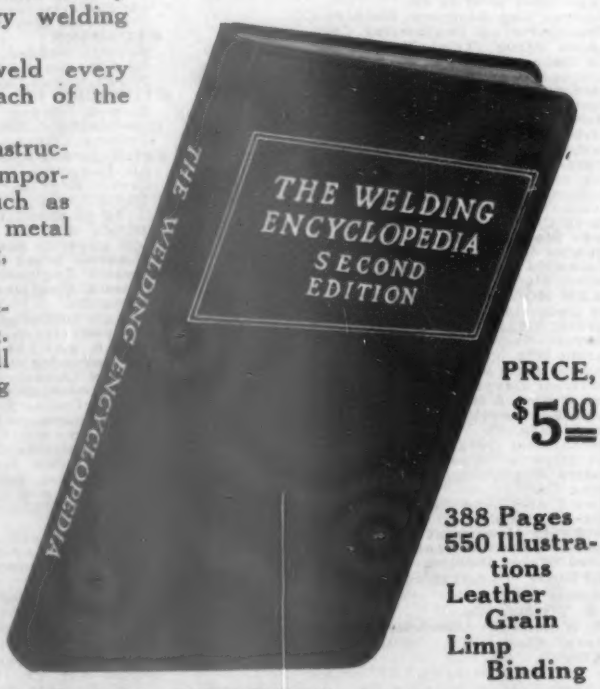

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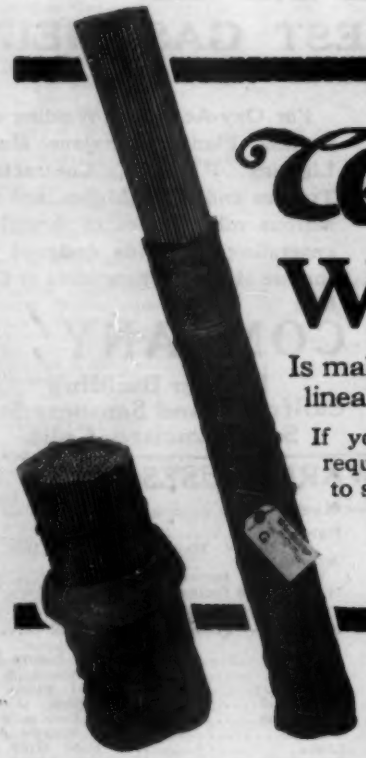

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for cutting
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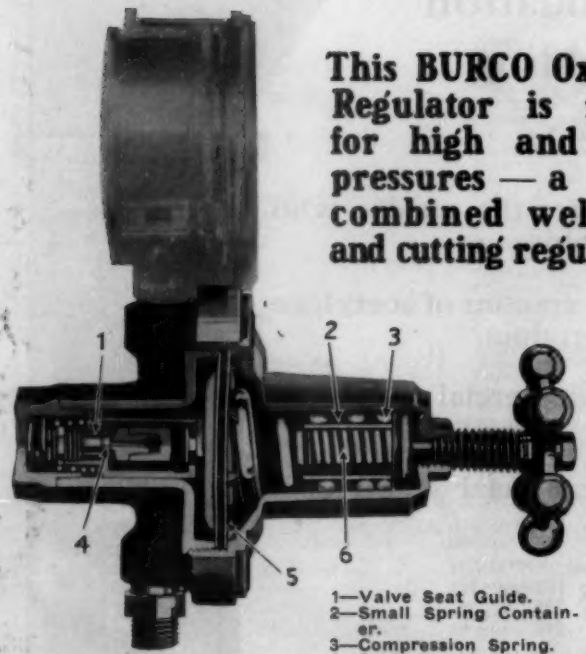

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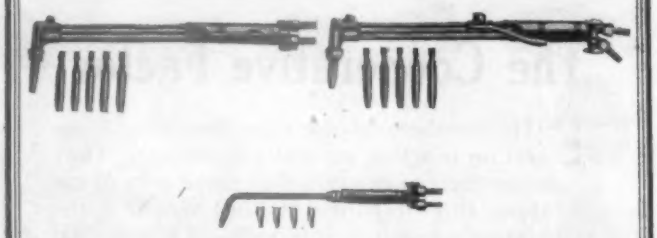

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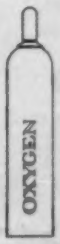

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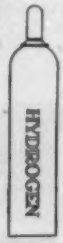

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Increase the quality of your welds.

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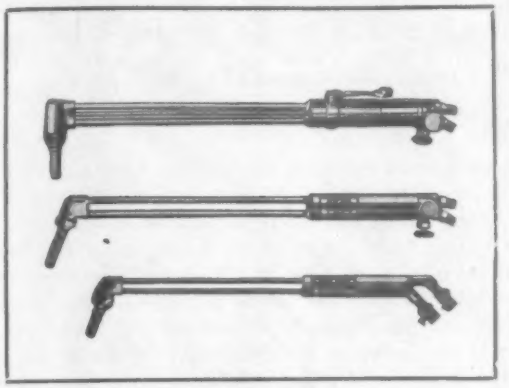

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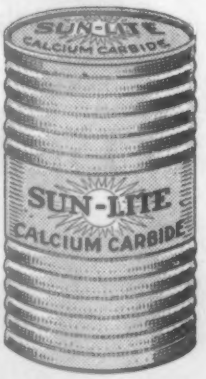

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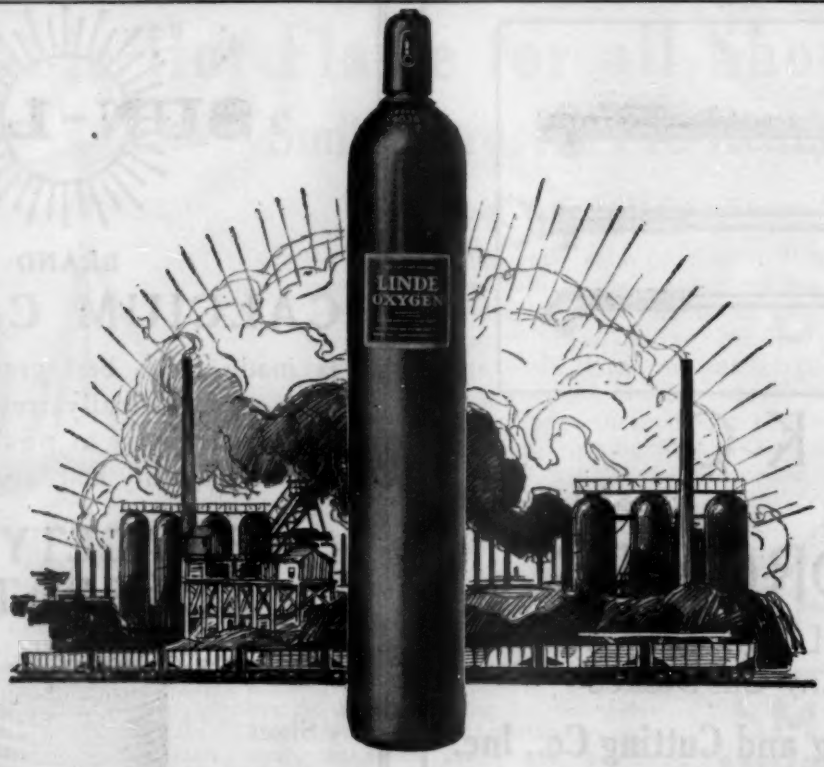

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LINDE OXYGEN

LOCOMOTIVE FRAME WELDING

Welder Must Have Room to Handle Torch Comfortably— Take All Time Necessary — Welders Work in Shifts

By A. F. Dillon

MUCH has been said in the past regarding Locomotive Frame Welding by the Oxy-Acetylene process. Some say it is impossible to make a successful frame weld by the above method, others say it can be done. As a matter of fact there is nothing impossible in making a real successful frame weld with a welding torch. In fact I feel confident that if any welding foreman in a railroad shop has his frame welding job properly systemized he can expect some mighty fine results, but he can also expect to have a great deal of work to do in instructing the welders how to handle the job, from the preparation to the finish. He also must watch the mechanics in his work of lining up, spreading and chipping the frame for a weld.

The welding of frames is by no means a new venture in any railroad shop, but considering the failures with the number of successful welds there is no doubt room for a better, and more systemized practice in handling them.

Failures in frame welds can be contributed to some of the following facts: Incompetent operators, poor grade of welding wire, improper spread, and to many times when a frame is being prepared for a weld, the Master Mechanic, Superintendent, General Foreman, or whoever has charge of such work, cannot see the need of removing such castings, rods, and riggings adjacent to the weld, or that would materially interfere with the welder in getting easy access to perform his duties with the utmost care.

Most foremen or those giving instructions for the removal of such parts, have the idea, that a welder can get into a knot hole, and make a successful weld but such is not the case, and neither can it be expected, that welding done under such conditions will be successful. Taking down the necessary parts many times saves the making of another weld later.

I have been instructed in the past to make a frame weld thru the spokes of a wheel. The result was what any broad-minded welder might expect, a failure.

Successful frame welding is accomplished by studying every detail that enters into the job, from the very start to the finish. Every man must know his particular part of the work, and when to execute it. Even the helper has his part to look after. He must see that the welding torches are in readiness at all times, and that oxygen, acetylene, welding rods, sledges, flatlers, fullers, etc. are ready for use.

Fig. 1. This Sort of Spreader Works Better than Jacks.

Taking the few above facts as a foundation for part of the preparation let us look into the preparation itself. We weld frames of all descriptions ranging in size from 3"x4" to 6"x9".

The illustration at the right shows an ingenious and effective method of holding heavy frames together for welding. Experience in this shop has also proven that better results are obtained when two or more operators are provided for the heavy jobs, so that they can work in shifts and avoid overfatigue. The tendency to hurry through the job is thus avoided. Below is a close-up view of a broken frame with lagging wired on to hold the heat.

Fig. 2. Lagging Helps to to Hold the Heat in the Frame.

Fig. 3. Putting a Heavier Front Section in an Old Frame.

The conditions existing in every frame weld are not the same. There may be frames of a 4x4 dimension that require more expansion than some other 4x4 because of its location and relation to some section of the locomotive. It may require more strength at one point than at another, it

may be in a position that is close coupled, and the expansion more difficult to get or it may be where there is plenty of room for expansion. Therefore the following table on expansions gives approximate figures, which we have found best for various classes of frames.

Size	Location of Break	Expansion
3"x4"	Top or Lower Rail—Pedestal	¼"
4"x4"	Top or Lower Rail—Jaw	5/16"
4"x4½"	Top Rail—Pedestal—Jaw	11/32"
4"x5"	Top or Lower Rail—Jaw	3/8"
5"x6"	Top Rail—Jaw	11/32"
6"x8"	Top Rail—Jaw	7/16"
6"x9"	Top Rail—Jaw	½"

The easiest method of spreading a frame is by the use of a frame spreader as shown in sketch. This spreader can be placed in most any part of the frame by cutting a slot in the fracture of the frame to enable the use of a wedge. Then by alternating the sledging first on the wedge in the frame, then to the wedge in the spreader, it is not difficult to obtain the desired expansion, and to keep it.

Fig. 4. Two Welders Making First Weld on Frame.

Fig. 5. Frame Weld Completed. Note That These Welds Are Strongly Reinforced.

The use of jacks is not so sure a way to hold your expansion, especially when the frame is spread the day before welding, because of the fact that the jacks will settle some if a heavy strain is left on them for any length of time, whereas the spreader being of solid construction you are able to hold the expansion.

You will note in illustrations 2, 3 and 4 the method employed in cutting a frame for a weld, the V being cut from both sides, after which it is chipped and a piece of ⅜ in. spring steel tacked to the bottom for a foundation to start the weld.

One of the main items in frame welding is that of holding a welding heat during the entire welding operation. This item has been the cause of many frame welds failing. During my time in welding I have used most every method of heating a frame for a weld, but the system we now use I feel has brought better results than any other.

The use of 1½ in. lagging tightly wired to the frame as shown in illustration 2 will hold more heat in a frame than any other method I know of. The heat generated by the two welding torches, which are kept on the frame from the start to the finish, will not radiate through the frame for any great distance, but the immediate section around the weld will be up to a welding heat until the weld is completed.

After the lagging is properly placed and tightly wired to the frame you are ready for the heat. Under the above preparation the use of three welding torches will bring the frame up to a welding heat more rapidly than any other method, and at the time the heat is obtained the welder is ready to continue instead of tearing down a furance as is the usual custom. Frames of large dimensions can be preheated by other methods very advantageously.

After the weld is completed the top and sides of the frame are trimmed with a welding torch after which it is shaped up by the use of Flatters, Fullers and a Sledge, which not only makes a neat looking weld, but closes up the grains of the steel thereby adding strength to the weld.

The piece of spring steel can easily be removed with a hammer, chisel and sledge and the bottom dressed up. Apply-

Fig. 6. Side View of Completed Frame.

ing lagging around the weld the frame is allowed to cool slowly.

In releasing the frame spreader there are a good many things to consider. In cases where it is hard to get the required expansion, and after getting it you know or rather realize the amount of strain on the spreader, the logical thing to do is to hold your heat until you have finished the weld before releasing the spreader. For frames which are not so hard to spread, the spreader can be released when the weld is three quarters finished. Under the above method of releasing the spreader we have very good results in getting the frame back to the original tram marks. However if the frame is ⅛ in. to ¼ in. long it is to an advantage inasmuch as you have a compression weld rather than a tension weld.

Our system in welding frames is that of taking all the time necessary, and following the idea of allowing the added metal to settle in as quiet a condition as it is possible, rather than letting the molten metal run all over the weld leaving laps, seams, and checks, which in some cases are almost impossible to get out. We do not allow any welder to raise his oxygen or acetylene pressure above 15 lbs., and we also caution them not to work fast. The welders are instructed to make a heavy ripple weld across the front of the weld up one side and then up the other, always working toward the center of the weld.

(Continued on Page 32)

AUTOMOBILE FENDER WELDING

Practice on Small Scrap Pieces Shows How to Get Best Results—Dented Fenders Can Be Made to Look Like New

Syracuse, New York,
Friday,

Dear Ed:

Having heard so much about a well known fender welder who has a shop near here, I decided today that I would make a special point of calling upon him and learning first hand just how he became so well known in this particular line. The effort was well worth while, for I saw work that was simply wonderful.

"It has always been my impression that welds on fenders were not very successful," I said to him. "From the looks of things around your shop you are evidently of a different opinion."

"You are quite right," he replied. "The weld as ordinarily applied to a fender is very short lived. It would seem that regardless of how much care and pains are exercised by the average welders that they do not carry the work quite far enough or, in other words, they do not analyze their problem and get at the source of the trouble. The only difference between the other fellow's shop and my own is that I have made a careful study of fender welding and people come to me from many miles around. Not that I make my charges any less than the other fellow, in fact I guess they are almost twice or three times as much; but, I do take pride in doing my work right. It is absolutely guaranteed and I never have a job come back."

"But I have heard welders many times state that welded fenders never stand up; you are evidently doing the impossible," I mentioned.

"Yes, I have heard that remark many a time myself, but I have welded thousands of fenders and can refer you to every customer I do work for. They will all tell you that fenders can be welded and that I am doing it every day successfully. Why, I have heard of men even trying to braze fenders, but they all have the same results. They last for a little while; look pretty good, and then break off. Personally I cannot understand why these welders do not figure out what their trouble is and correct it, the same as I have done."

"But, tell me, what is this secret of yours. Aren't all fenders made of the same metal and by the same process, or do they have to be treated differently?"

"No, they are not all made the same, each manufacturer has a different design; they draw their metal different and in many cases use different kinds of material," he answered. "The most common metal of course is steel, but on many of the high priced cars sheet aluminum is used, and that of course is treated entirely different from the steel."

"That's all well and good," I said, "but I thought you were going to tell me how you get around the eventual breakage, which characterizes so many of the welds you were telling me about."

"As I said before, the only way to get at the source of the trouble and overcome it is to do a little analyzing, and having done so I have found out that a fender breaks from one of four different causes, which are as follows:

1. Vibration
2. Accident
3. Internal strains in forming the metal.
4. Additional strains due to loosening of supports

You see we welders are really M. D.s. (metal doctors) and must know the cause before we can permanently "cure" our patients. You see I have placed vibration first for on automobiles and trucks there is usually a great deal of it to be found and the metal breaks, of fatigue more than anything else. Accidents come next, but this is really an outside force and the fender itself is not to blame. Internal strains left in the metal by the manufacture will always show up eventually. The last cause I mentioned, that of added strains, is another cause which cannot be attributed directly to the fender. It is natural that if additional force is brought to play upon the fender and it is not designed to carry it, that it will result in a break."

"I follow you, I remarked, "and I can readily see your point. Now the question comes to be, how can you by welding remove all these four causes?"

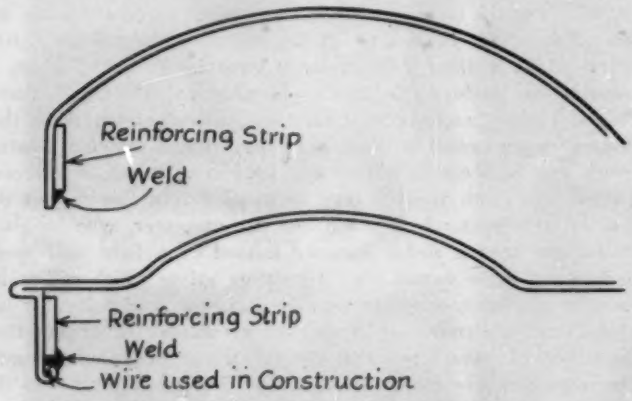
"Now you are taking too much for granted," my fender friend replied. "I didn't say that we were going to remove all four causes in our welding, because it's very seldom that we have more than one cause to account for the breakage. However; before I go into the actual welding, I am going to tell you first of all about the tools and apparatus required to do the work, for they are to my mind, just as important as the welding itself. First of all a light welding torch must be available, which is capable of producing a small and very soft "neutral" flame. While I have indicated a small torch, that does not mean that a large torch cannot be used, but I have found that much better work can be accomplished with a light small torch, on account of the ease with which it can be handled. In this respect the use of a large torch is much like the carpenter, who builds a house and uses a sledge hammer instead of a light half-pound hammer. In the second place regulating valves which will maintain an absolutely constant pressure must be used. It does not make much difference as to the size or number of gauges they have, only I have found that the larger the diaphragm, usually the more sensitive the pressure. After the regulators comes the filler rod, or wire. This should be either one-sixteenth inch or five thirty-seconds. This material must be soft, clean and free from carbon. The next thing in order is the portable grinding wheel, and after that a wood mallet and block of lead. Then last, but by no means least, is the finishing paint."

"You certainly have things right down at your fingers' ends," I said. "Evidently this is not the first time that you have been asked to tell about your success as a fender welder."

"You're perfectly right, sonny, this is not the first time, but it is seldom that I take the time or trouble to tell people about it, the same as I am you. For the life of me I can't quite understand it myself, why I should take this time, for I have a lot of work waiting; but you know how it is, 'all work and no play makes Jack a dull boy.' "

"So far as the fenders are concerned," he continued, "they ought to be difficult to weld on account of their thinness, but they really are not. In fact very little 'know-how' and experience is required. I don't blame you for smiling after all I have said, but the remarks I just made are just as true as I am standing here. The ordinary steel fender is made of rolled stock, and if a weld is made, we all know that the weld has all the ear-marks of a casting. Such being the case, and the metal so thin it is quite easy to see why the welds open up after being in use a short while. Now, I can't tell you exactly how to do the actual welding on fenders, but I can give you a few pointers that will help out some of your friends, if they follow my advice. First of all some scrap sheet metal should be found to practice on. These pieces should be the same thickness as the ordinary fender. Before starting to weld a very small tip should be placed in the welding torch, and the end of the neutral flame, applied to the center of one of these scrap pieces. By holding the flame in contact with the metal until it just starts to melt and then ad-

vancing the flame along the surface; just melting the metal and then passing on, the right conception of a welding flame for this type of work can be easily obtained. The flame must be 'soft,' for the softness of the flame is extremely important. Care should be exercised to avoid sparking and burning of holes. When satisfied that the correct welding flame has been obtained then two pieces of scrap should be welded together, first without adding any filling rods and later on by using some filler. In adding the filler rod, as little should be used as possible, for any reinforcement on the surface must be removed when doing a real fender job. In practicing on these small parts, it is well to have the part being welded removed from any contact so that it will be similar in every respect to a regular job. After a little practice it will be noticed that a bead or reinforcement will form directly under the weld if the weld is properly made. By welding and breaking a number of these specimens before attempting fenders, any operator can satisfy himself as to his results. If he can weld small parts and have them hold successfully, he certainly can expect the same results on his fenders. However, he should not be satisfied in welding his specimens all in a flat position.



Reinforcing Fender Welds Makes Them Hold.

Much better results can be accomplished if he stands them on end, as a great deal of fender welding must be made in a vertical position. It will be noticed when working on these small parts, that if two edges are butted close together and the weld started at one end, that at the other end the edges will overlap as the welding progresses in that direction. Realizing that this action takes place, allowance can be many times made in the fenders to take care of this contraction or closing together. At other times it is well to 'tack' the two edges together every two or three inches before starting to weld. Always start from the closed end of a crack and work towards the open. Another point to remember is that this thin metal will warp and buckle as the heat is applied. Much of this trouble can be overcome by the manner in which the flame is applied. By holding the flame to the line of weld and using care very little warping will occur."

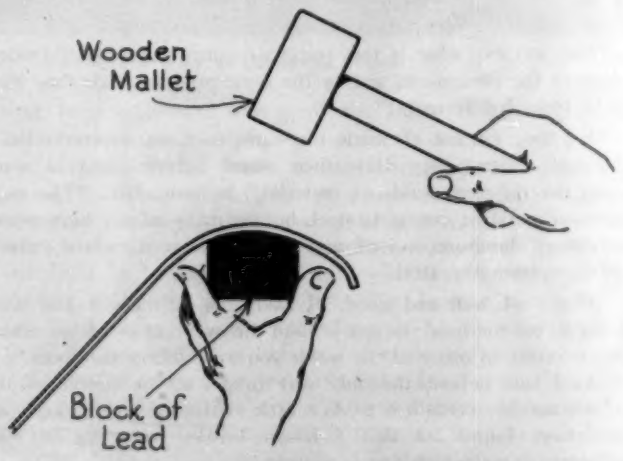
"That part is all well and good, but I have seen welders do all that and more besides and it seemed invariably that the harder they tried the less success they had. Surely there is something more that you have not told me about as yet."

"I was just coming to that point directly," he said. "When a fender breaks, it generally does so on the outer edge. Realizing that the original metal in the fender at the point of break was not strong enough, it is reasonable to suppose that the weld will not hold unless it is reinforced. This, I believe, is the whole trick in fender welding, namely: to make a weld which will hold the two edges together and reinforce it in a manner which cannot be seen. Now, here are the two common forms of fender construction. By taking a small strip about twice the thickness of the metal used in the fender, and three-quarters of an inch to an inch wide and placing it just inside of the outer edge and welding it along the lower edge, as you see, the fender is made twice as strong at that particular point where so much of the strain comes. Now, it is very hard to hold this small reinforcing piece in place; but by 'tacking' it to the end of a filler rod the weld can be started and later on the filler rod melted off. Remember it is not necessary to weld on all four edges with this extra strip. Along the lower edge is all that is necessary."

"How about those fenders which are made of aluminum?" I asked.

"Aluminum fenders are much more difficult to weld than those made of steel, but with a little practice much better results can be accomplished. The only possible way to repair aluminum fenders is to use a sheet aluminum flux. This is very expensive and cannot be obtained in a good grade for much less than $5.00 per pound. The best kind of a filler rod for this kind of work is small strips sheared off a sheet of aluminum fourteen or sixteen gauge in thickness. The same procedure holds for welding a few specimens together before starting on the fenders as I have previously told you about in steel, and after the weld is made the same kind of a reinforcing strip is used. While I have said that fenders of this kind were more difficult to weld than steel, they are really easier after a welder gets accustomed to them. The whole trouble is that they are generally few and far between, and just about the time a fellow gets fairly good on them he does not see any more for a long while; and therefore gets out of practice.

"While I am at it," he continued, "I am just going to tell you a little bit about finishing up work of this kind. I have found from experience that it certainly does pay to finish fenders in good style. Many times you can charge anywhere from two to three times as much for a finished job as you can for one which is left rough, and it only takes a few minutes to do the finishing. After the welding is done, bring out the electric grinder, dress down the surplus metal and then finish if off with a file. If there are any buckles, they can be removed, quicker than you can say 'Jack Robinson,' by using a block of lead and a wooden mallet. Place the lead block on the under side of the fender and rap gently with a mallet on the other. The buckles will vanish about as quick as dirt does before our good friend 'Dutch Cleanser.' And, in connection with the buckles surrounding the welds if there are a few others to be found in the fender that have no relation to the weld, it takes but a jiffy to remove them as well, and it certainly



Removing Buckles With Wood Mallet.

pleases the customer. When you come right down to it, the owner of a car takes considerable pride in it, whether it is a Ford of a Packard; therefore, finish up a good job in good style. After it has been all smoothed up give it a rub with some quick-drying stove pipe enamel and charge an extra dollar or two for so doing. That has always been my policy and I have found it a very successful one."

So much for the welding of fenders, Ed. I guess they are like everything else in this welding line and there is a knack in doing them. I couldn't help but smile when my friend was telling how

LAYOUT OF A MODERN WELDING SHOP

Up-to-date San Francisco Shop is Equipped to Handle All Varieties of Repair Jobs

By R. L. Re Qua*

THE opening of a new and modernly equipped shop for the purpose of carrying on any business is generally of interest to others engaged in that business and with that idea in mind the following description has been undertaken. No claims for special originality in layout are made, but it is believed that the particular shop here described contains sufficient equipment to warrant going into some detail as to the manner of its arrangement in the hope that others who are directly or indirectly engaged in welding may find here and there a hint that will help them in their own particular case and in so doing benefit the business as a whole.

Photograph of Shop Interior Showing Convenient Arrangement of Equipment.

The shop is located in the city of San Francisco. In choosing the location within the city the attempt was made to locate as nearly as possible at the center of gravity of the industrial district, that is to say, at a point equally distant from all of the important centers of local industries as possible. Practically, this meant in San Francisco a point midway between "Automobile Row" and the center of the machine shop district, or near Fourth and Howard streets.

The building chosen is of concrete construction of the type known as "Class A" in San Francisco indicating approved fireproof construction. The floor space amounts to about 3,500 square feet, with a 50-foot frontage extending back 60 feet for the full width of the building and a further 20 feet in the bay where the hoist is located. Garage type doors on the right are sufficiently large to accommodate automobile trucks and give a straight path back to the preheater. A smaller door on the left opens into the office from which a second small door opens directly into the shop. Steel sash windows on all sides provide light and have standard provision for ventilation in addition to which special means for ventilation are being provided over the preheater bed.

The electric welding unit is located in the corner back of the office at the point E in the diagram. The generator is driven by an alternating current motor with across-the-line type starter having provision for remote control from various points in the shop by means of push-button stations. A reversing switch consisting of a 200 ampere double-pole double-throw knife switch is connected to the outgoing leads from the generator, for the purpose of reversing the polarity when arc welding on cast iron or with special composition electrodes. The leads are of extra flexible cable of length sufficient to reach all parts of the shop. When not in use they are coiled and hung out of the way, as shown in the photograph. At the end of the electrode cable a still more flexible conductor about 10 feet long connects to the electrode holder and at the end of the ground lead a small strip of iron is attached for convenience in clamping to automobile frames and the like.

Oxy-acetylene stations are located at the points L and M. Each station consists of the two tanks and racks above containing the necessary tips, torches, wrenches, lighters, etc. Twenty-five feet of hose is kept connected to the regulators at all times and adapters and extra hose are provided for cases where a further stretch is necessary. Large size acetylene tanks are kept at these stations, consequently no provision is necessary to keep them from being overturned but a small loop of chain anchored to the concrete post over each is arranged to be slipped over the valve of the oxygen tanks to prevent their being pulled over by the drag on the hose. Reserve tanks and empties are located at J as shown.

A gas welding bench is located at C between the two stations described above. It is constructed of angle iron members supporting a sheet iron shelf near the floor and providing a shallow box-like top for retaining the fire bricks upon which the work rests. The shelf beneath is arranged with spaces for holding filler rods most commonly used, such as mild steel, cast iron and aluminum, as well as the necessary fluxes. In addition space is provided for carbon plates, carbon paste, copper sheet used as forms and a hammer, pair of pliers and wire brush.

The preheater A is located in the back bay where it's use cannot interfere with other work on the floor, and where in addition adequate ventilation can be arranged to carry off the heavy smoke that attends the heating of very greasy castings and the fumes

Proprietor, ReQua-Weart Co., San Francisco.

from welding on brasses and bronzes. It consists of an iron band eight feet in diameter and eight inches high, bolted to the floor and filled with cinders. Immediately behind it in the corner is located the charcoal bin.

Over the preheater the hoist B has been erected. This consists of I-beams, angles and cross rods with turnbuckles; the whole arranged to sustain a working load of two tons from any point on the structure. The topmost beam is set at an angle as shown and carries the hoist trolley from a point over the center of the

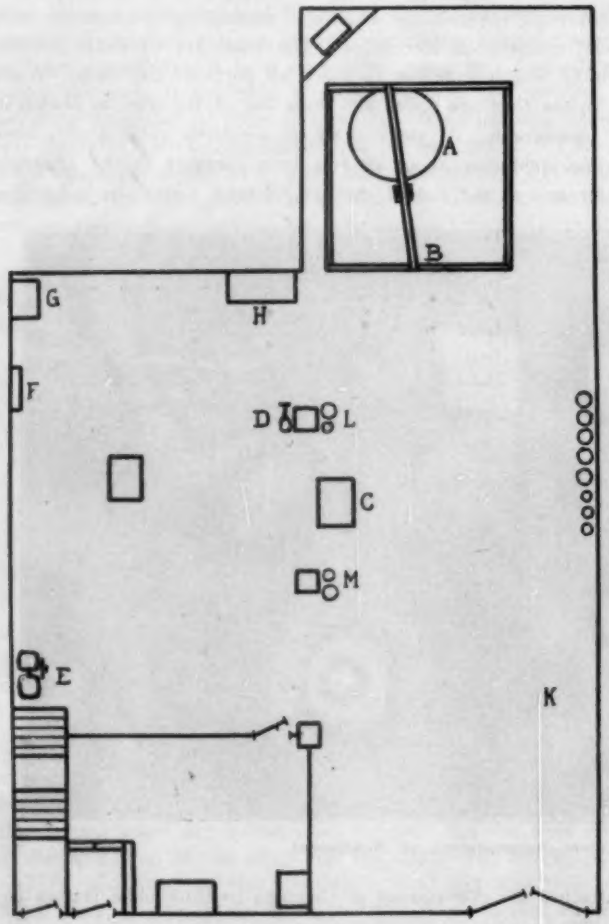


Diagram of Shop Layout.

preheater to the center of the front frame member. This allows of backing a truck squarly between the front columns and unloading a casting therefrom onto the preheater with a minimum of effort. The hoist structure is of incidental interest in that it contains no bolts nor rivets, all members being electrically welded to one another.

A portable grinder is mounted at D on the concrete post. Sufficient conductor is provided so that when desired the device may be carried as far as the preheater bed. When not otherwise used the grinder is mounted in a welded wall fixture arranged with quick acting clamps so that the whole functions as a stationary post grinder.

In addition to the above, there are various benches, vises, clamp racks, tip racks, etc., located at convenient points around the shop. A wall fixture near the hoist holds the asbestos paper roll so that it may be unrolled evenly and torn off without waste. A wall rack in another corner holds soldering fluxes, pastes and special fillers such as aluminum solder, silver solder, etc. Another contains spaces for electrodes of special composition, such as high carbon steel, bronze, nickel, manganese steel, etc., and a shop desk is provided where shop orders, etc., may be written out.

The above completes the description of the shop proper. Office space is provided in the front with a combined counter and railing between the desk room and the door. A desk, drafting table and a book rack complete the equipment of this important but preferably small part of the shop.

BURDETT OXYGEN COMPANY PLANTS DOUBLING CAPACITY

One of the best indications of the amount of welding that is apt to be done in the next year or two is the promise of an extra large demand for compressed oxygen. The Burdett Oxygen Company of Chicago, which operates a chain of oxygen producing plants in Chicago, Ill, Ft. Worth, Texas, Detroit, Mich., Norristown, Pa., Chattanooga, Tenn., Pittsburgh, Pa., and Oklahoma City, Okla., has under way a program of expansion which means doubling the capacity of all of these plants. It is stated by officials of the company that the amount of business done in the first quarter of 1923 is well in excess of business done in any previous first quarter of the history of the company.

The demand for the various Burdett products has made necessary an increase in the production facilities. Several of the plants are already equipped to produce the additional volume of oxygen which is being ordered, and it is reported that by the 1st of June the program will have been completed and that all seven of the plants will be ready for full production on the new basis.

This is an unusually good indication of the possibilities of extending the welding processes in the near future, and the fact that such growth is possible should certainly increase the amount of confidence which already exists that 1923 is going to be a good year.

KANSAS CITY OXYGEN GAS COMPANY GROWS

Announcement has been made of the removal of the display and office rooms of the Kansas City Oxygen Gas Company, Kansas City, Mo., to new and larger quarters at 2012 Grand Avenue. Besides compressed gases the products of the company include gas equipment and supplies.

MANGANESE WELDING INFORMATION

Folders recently issued by the Manganese Steel Forge Company, of Philadelphia, describe the uses of their line of Rol-Man manganese steel welding rods for track work, mills, mines, smelters, dredging plants, furnaces, etc. A very complete list of the articles which can be welded is given, under the heading, "Why and Where." This is followed by detailed descriptions of the rods. One page of each of the folders is devoted to instructions and suggestions for welding manganese steel by both the electric and oxy-acetylene processes.

GAS PRODUCTS ASSOCIATION APPOINTS NEW SECRETARY

Announcement has been made of the appointment of Mr. Chester E. Price as secretary of the Gas Products Association, in the place of Mr. H. W. Kurtz, who recently resigned. Mr. Price was formerly field secretary of the National Metal Trades Association.

H. W. COOK LEAVES ACETYLENE JOURNAL

H. W. Cook, who has been associated with the Acetylene Journal, Chicago, for the past four years, as managing editor, recently resigned to accept a position in the sales department of the Union Carbide Sales Company. A number of Mr. Cook's friends in the welding trade in the Chicago district joined in entertaining him at a pleasant farewell dinner at the Sherman Hotel, on the evening of May 8th.

WELDING OIL STORAGE TANKS

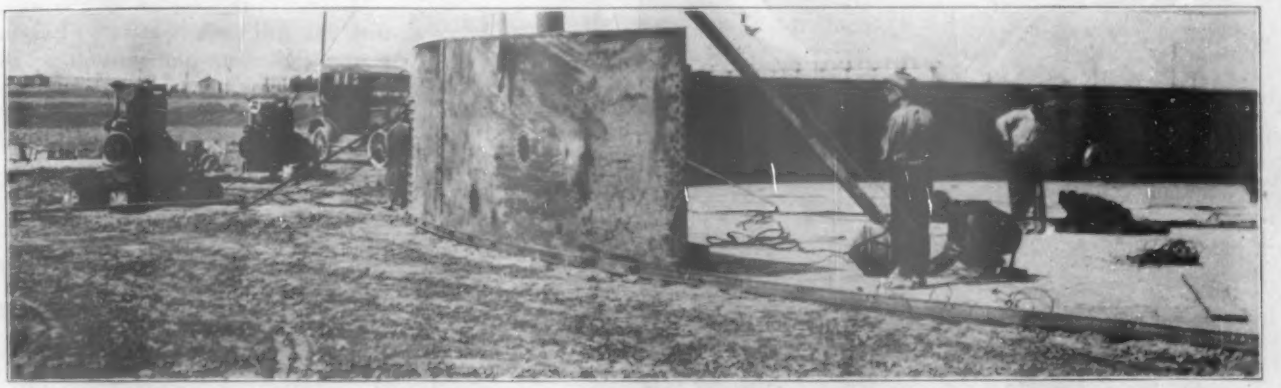
Bottoms and Roofs Are Welded for Containers Having a Storage Capacity of Eighty Thousand Barrels of Oil

FROM the oil fields of the Southwest comes the story of an extremely significant welding accomplishment, that of welding bottoms and roofs for monster oil storage tanks which have previously been welded. A tank manufacturer having consented to build one 80,000-barrel tank with the bottom welded, the job was watched with considerable interest, because success would probably mean a greatly increased field for welding in the oil industry.

The first tank welded was 117 feet in diameter. The straight steel sheets for the bottom were 18 feet by 6 feet by ¼ inch, weighing about 900 pounds. Sketch sheets were made of the same stock, but varied in size and shape. The sheets were lapped about 1¼ inches and then tacked to hold them in place as they were laid. One tack was placed on the long seam and one on the cross seam, then as many more tacks were put on as possible before the next sheet was in place. Tack welds were about an inch long and spaced at intervals of about 18 inches. After all the sheets were in place the tacking was finished in those portions where longer intervals had been left in the first course. The complete construction crew contained a number of unskilled laborers for handling material, and since about half the labor cost was for cheap labor erecting crews had always been organized on the work in such manner as to keep up with the laborers. This imposed a rather unusual condition on the welders on this job, as they were obliged to suit the welding procedure to the main program, in order to keep down the total cost of the entire construction.

Another interesting detail of the first bottom was that it was not welded on the ground, but on cribbing which was made by placing wooden horses in rows parallel to the long seams and about a foot from the edges of the sheets. One row of horses was used for each long seam. After the bottom was finished, the tank was tested by taking out the center supports, and as will be described later, tested so well that later bottoms were built directly on the ground.

When no trouble was experienced in getting the plates together the tack welds took about five seconds each. That is the actual time under the best working conditions. It took two men to do the tacking, one man guiding the heavy weight which pressed the sheets together, and the welder handling the electrode. When the tacking was completed an inspection was made for bad places where sheets were bent or would not come together by the ordinary means. They were forced together and tacked extra strong. An outside angle-iron ring was then tacked in place and the first shell ring was hung on the angle. This shell ring served the very useful purpose of protecting the welder from most of the wind.



Tacking the Bottom. Part of the First Shell Ring is in Place. Two Gasoline Engine Driven Generator Arc Welding Sets in Action at Left.

Welding was started on the long seam at the center of the tank and carried out toward the outside angle iron. When the long seam was finished the 6-foot cross seams for that section were welded. Then the second long seam was welded and the second set of cross seams, and so on across the tank to the angle iron. The first long seam was 117 feet and the last long seam near the angle iron was about 60 feet.

Particular pains were taken in welding the first bottom, not to work up any contraction strains. The welder would weld three

Removing Support from First Bottom.

Laying Second Bottom on Ground.

Economize by Buying Safe Equipment.

There is no S

Another Revol

in the Oxy-A

THE BASTIA

In the Manufact

THE NEW REGO NOZZLE and seat co and compression of the gas of the regul turn the full tank pressure of about 2,000 pou causes lightning-like movement of the regulat invariably in spontaneous combustion of the of the best engineers in the industry for ye is embodied in REGO trade-marked regulato

OTH

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GOOD WELDING DEPENDEN

Gases for welding and cutting are usu pressure in the tank naturally falls. Good we at absolutely uniform and constant pressure a pressure but volume has been sacrificed and vi actual use to be so constructed as to maintain an ample and constant volume.

WIDE RA

The REGO double spring construction of pressures and a heavy spring to govern t sitive regulator than one with only one spri

The seat and nozzle of REGO regulato The closing movement is not controlled by s the yoke and seat tight against the inlet nozz proportion as the pressure increases in the bod is no possibility of damage because of worn-o

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lengths of electrode wire forward, then one backward. But before the first two bottoms and roofs had been completed it was found that such care was not necessary, as no dangerous contraction strains were set up in the weld, even when 15 inches or more were welded straight ahead. This would probably not be true if a butt joint were used instead of the lap joint. The only evidences of contraction were long waves at right angles to the

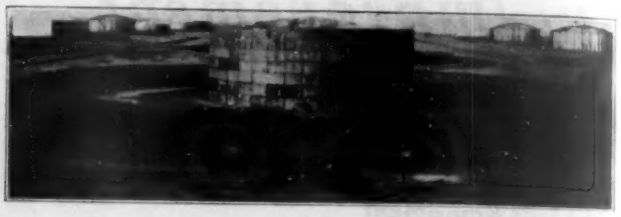
First Bottom Ready for Test.

welding and generally on that part of the bottom which was not welded. It is reported, however, that the welded bottoms made on this job were more level than the usual run of riveted bottoms.

A comparatively heavy bead was used on the first bottom because it was the first one and it was not known definitely what strains would be set up, or how severely it would be tested. The constructing company had to be convinced that the welded joint was as good or better than a riveted joint, as far as both tensile strength and tightness were concerned. The weld on the angle iron, for example, was started quite heavy, but the latter half was about ⅜x⅜ inch.

When the first bottom was finished it was tested with 6 inches of water and didn't show a single leak in nearly 3,000 feet of welding. After this test the water was drained off and the tank jacked up on the cribbing at the outside, and the horses knocked from under the center. This left the entire bottom suspended by the weld on the angle iron, and the center sagged nearly 30 inches from the level of the ring. The bottom was then lowered to the ground. No leaks nor breaks developed throughout this very severe test. It is believed that this is the first tank bottom of this size ever welded in this manner and subjected to such testing. About half a ton of electrode material had been used.

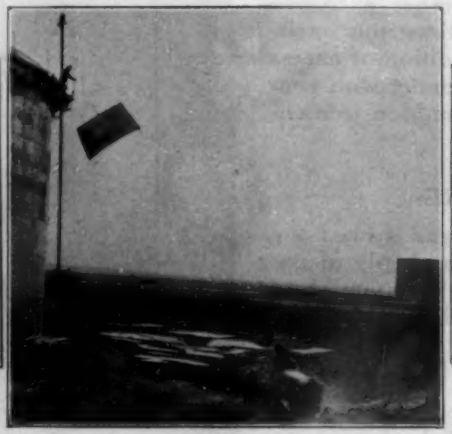
The tests on the first bottom had proved so successful that the second bottom was placed directly on the ground, the plates being painted before they were laid. The time taken to lay the bottom was, of course, greatly reduced. The tacking time was also shortened, as it was easier to set up the bad places against the ground than when the plates were supported on horses.



First Tank Ready for Roof.

The outside angle iron was welded first so the shell could be driven while the welding proceeded on the bottom. The second bottom took about two-thirds the time of the first and cost about $100 less. By the time it was finished the first roof was ready to be laid and welded.

Long Seams Welded. Note Level Bottom Secured.

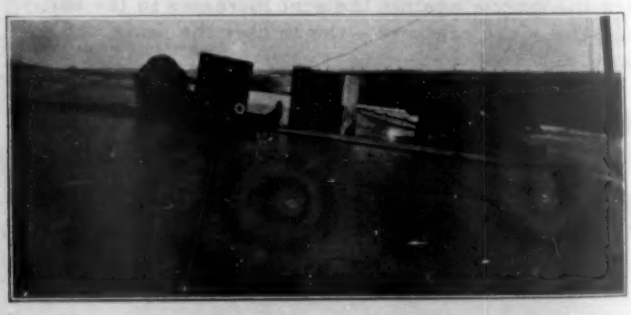


Raising the Roof Sheets.

Motor Generator and Transformer Welding Sets Were Used.

Tacking and welding on the roof proceeded about the same as on the bottoms except that while the welders were troubled on the bottom with rain, which lodged between the laps and had to be blown out with air, and sometimes with sleet and cold weather, on the roofs the greatest trouble was caused by wind and cold. Here the welders resorted to windshields for protection. Windshields were made of two 2-inch by 18-inch by 4-foot faces fastened at right angles. They weighed about 100 pounds, but the wind

Welding Roof to Top Angle Iron.



Closing the Long Seams on the Roof.

was sometimes strong enough to blow them against the welder, or off the roof.

Just as the angle iron at the bottom had been riveted to the first shell ring and welded to the bottom, so the angle iron at the top was rivetted to the top shell ring, and welded to the roof.

It must be remembered that welders on this job had to compete with a very efficient organization. They build tanks quickly in the oil regions, and rivetting crews are well accustomed to working along with the material handling crews. The sheets weigh in the neighborhood of 900 pounds and eight men are required to handle one of them. That they did compete successfully

Wind Shields Furnish Some Protection for the Welder.

may be judged from the report that twenty more roofs were ordered welded in the Northwest, several bottoms and roofs in the South, and more than a score of bottoms and roofs on the present location. This means something like forty miles of lap welding to be done in this field in the next six months.

The construction described above offered abundant opportunity for rivalry between the operators, and to make it more interesting, several different types of welding apparatus were tried out. Standard types of both direct and alternating current welders taking current from the power supply lines were used, and one friction-drive, gasoline-driven motor generator set.

NEW G-E WELDING ELECTRODE

A recent folder issued by the Merchandise Department of the General Electric Company, Bridgeport, Conn., announces an electrode which is radically different from other electrodes in its make-up and characteristics. It consists of a central metallic core surrounded by a layer of flux which is enclosed by an outer metallic layer or sheath. This prevents the flaking off of the flux in handling and insures that it will not be dissipated by the arc before the actual melting down of the metallic elements of the electrode. It also gives a clean metallic surface for feeding from the holder into the electrode, and makes it unnecessary for the flux to contain a binding agent. The quantity of flux is therefore quite small and the slag coating on the weld correspondingly thin. It is reported that good results have been secured by using this electrode for the metallic arc welding of cast iron. It may be used, however, for all ordinary welding operations using either alternating or direct current. It is made in $\frac{3}{32}$", $\frac{1}{8}$" and $\frac{5}{32}$" diameters, and is supplied in short lengths, coils or reels.

The spring luncheon of the Compressed Gas Manufacturers' Association is scheduled to be held at 1:00 P. M., Thursday, May 17, at the Hotel Astor, New York. The May executive board meeting will be held immediately afterwards.

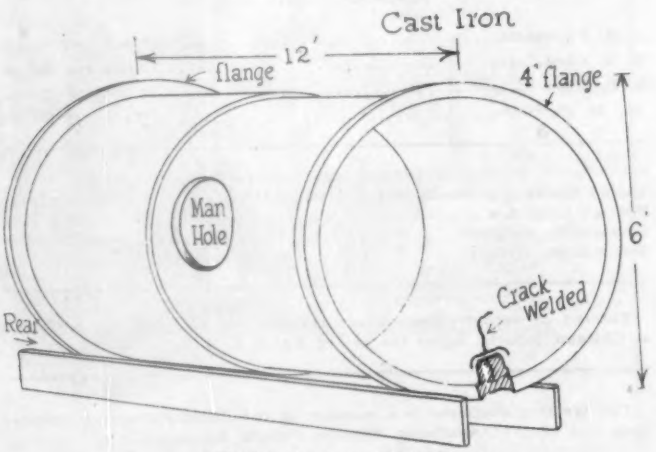
The Commercial Acetylene Supply Company, New York, announces the removal of its Chicago office from 542 South Dearborn St., to the Railway Exchange Building, 80 East Jackson St.

WELDED CRACK IN DIE BELT

By Harry Kohler

The foreman of the foundry department called my attention to a 12-ft. die belt 6 ft. high. They broke or drilled a piece out of the flange and the body that was defective. The foundry department wanted to burn it in the next morning, but noticed it was cracked. They did the same thing again on the 7th of March, and it looked the same, so they called the machinery foreman, superintendent, chief engineer and foreman. They all were standing around while I was to see what I could do.

I've got two heavy weights that the molders use 18 in. high. I laid the piece on top of two of them about 36 in. apart so that I could build my fire underneath. The second time the foundry burned the patch was all right, but you will notice a crack back of it. I chipped this out. It was 23 in. wide and



Welded Crack in Die Belt.

29 in. long. It took me eight hours, from half past eight until half past five o'clock. I took it real slow in heating so the strain of it would give only constantly. As the flanges rested on the weights that gave space for the flame to go around the belt. By the time it got hot on top the bottom was cherry red from a wood fire. I put a sheet in front to keep the smoke from me, then fired it from the rear and covered it with asbestos. Around the welding place after I was through I put on one wheel barrow full of charcoal to keep the heat up. I knew wood would not take care of it, because it gets cold too quickly. I covered the side, between the flanges with brick, laid up brick at the rear end, and shoveled sand as high as the weights so no air could get in. The next morning it was still hot and I could not touch it until after I lifted the asbestos. What I wanted to see was if it was good, and I tell you it looked so good I covered it quick and laughed to myself and put a few shovels of hot sand on top of the asbestos.

WELDING A DRAIN PIPE

By Geo. W. Cooper

We found it necessary in a large factory to cut a piece of 6-in. steel pipe which had become rusted out. The pipe was a drain line from four hydraulic presses and as it lay on a concrete floor and could not be raised the master mechanic was doubtful about being able to weld it. He told me, however, to go ahead and do the best I could, so I went about it in this manner:

We measured the bad section which was about 6 ft. in length, then in order not to stop the presses longer than possible we cut the new piece, got it ready, then got our cutting and welding outfit on the job. We had them shut down the presses and then cut out the bad piece, put in the new piece, and welded around it as far as we could go. As it lay on the concrete floor we could not weld all around it. The master mechanic thought we were stuck, but I took the cutting torch and cut an oblong section out of the top of the pipe, large enough so I could weld on the inside. In this way I welded the bottom on the inside and then welded the piece in the top, which I had cut out, and the job was done. We only had the presses shut down about 40 minutes.

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The Electrode as a Special Product

EXPERIMENT and research have resulted in the production of metallic electrodes which are considerably different from fence wire and hay wire. It was all right to weld with any old wire in the early days of arc welding when the requirements of electrode material were unknown, just as it was all right to cross the prairies in ox-carts before railroad tracks were laid. But the present demand is for better welds and the future demand will be for perfect welds. To accomplish them some attention will have to be given to the electrode material. At present the market offers a special electrode for practically every type of work. Many of them have been developed as the result of long and costly study. They have made possible far better work over a wider range of jobs than could have been accomplished ten years ago. The difficulties presented in many welding op erations which are being attempted today suggest that more improvements can be made in the manufacture of electrode material. One of the most interesting suggestions made is that greater penetrative poyer may be secured, thus cutting down the cost of preparing the work, and increasing the speed of the operation. All this attention to further improvement points to the need of care in the selection of materials if the best possible welds are to be secured.

A Hint for the Salesman

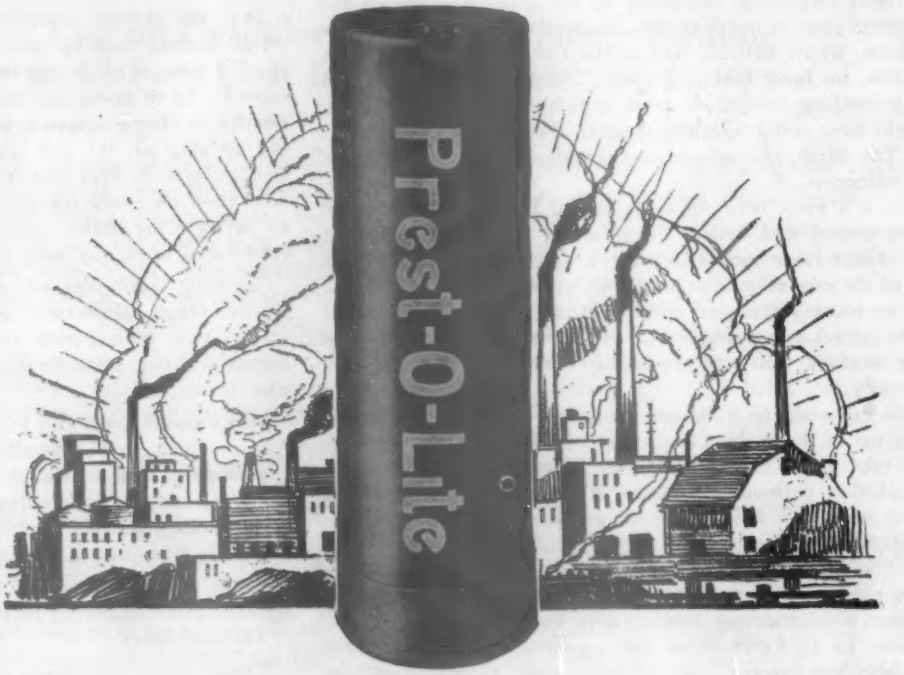
THOUSANDS of newsboys of all nationalities, are shrieking "Extra!" into the ears of sound-fatigued Chicagoans, all day long. Their sales talk becomes part of the city noise, irritating rather than appealing. In one of the outlying districts, however, there is an old Negro selling. As the commuters pass him in the morning he shows about twenty big white teeth and offers, "nice fresh morning papers!" The smiles of his patrons are proof enough that he has sold them something more than the day's news. The get just a little chuckle at the ingenuity displayed in finding a new selling point for a newspaper. Novelty furnishes the appeal. "Nice fresh welding torches," may not be the correct adaptation of the idea to selling talk just a little different, and more interesting than the conventional methods which are almost universally used.

Improving the Deposit

WHERE metal deposited by the arc or the torch proves to be below the desired quality the operator has recourse to several devices which may lead to improvement. One investigator recommends that extreme care be exercised in gas welding to float out the slag and to keep the deposited metal from biting into the parent metal. The corresponding caution in arc welding is to clean the oxide from each deposited layer before depositing the next layer. The amount of oxidation can be minized by holding a short arc and se lecting a welding wire carefully. No more carbon should be present in the welding wire or electrode than is absolutely necessary, says this investigator, and further emphasis is placed upon the need of uniformity of welding material.

Denver Opportunity School

"MUNICIPAL Facts" a magazine published by the City and County of Denver, describes in its March issue Denver's Opportunity Public School, which has grown famous throughout the country as one of the most efficient educational institutions of America. This school has no entrance requirements and the students come at such hours as they can spare from their work. There are also no age limitations. Daily attendance is in the neighborhood of 3,500. The instructors, wherever possible, are persons taken from the shops of the city. Not only do students secure practical instruction but they are placed in touch with employers. It is reported that since September, the beginning of this school year, forty acetylene and electrical welders have been placed in positions by the school. The school has equipment for training men in both of these welding processes.



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CHICAGO TO HAVE VOCATIONAL AND TRADE SCHOOLS EXPOSITION

The most interesting exposition of the country scheduled for the current year is the National Vocational and Trade Schools Exposition, which will be held at the Coliseum, Chicago, from May 30th to June 10th, inclusive. Three hundred vocational schools, teaching everything from bricklaying to law and medicine, will have active exhibits showing their courses of instruction. The variety of schools includes those for both boys' and girls' instruction.

There is a great need for more skilled help of all kinds, and it is recognized that despite the recurrent cry of unemployment highly skilled labor can always get a job at good wages. The object of the exposition is primarily to interest and enthuse young people to learn a trade or vocation, though the exposition will not only attract young people but will appeal to men and women already working who want to improve their condition and earn more money.

People can visit the Coliseum, study the active demonstrations to be given in the various booths, and select a vocation they desire to take up. They can learn all about the cost of scholarships, whether personal instruction or correspondence, what the vocation pays when it is completed, and how long it takes to become proficient in the trade or profession.

There will also be splendid exhibits attractive to both sexes, such as commercial art, bookkeeping, stenography, photography, journalism, hotel training, dramatic arts, and many others.

Director O. C. Lightner, at the exposition headquarters, 1716 South Michigan avenue, says: "The great Coliseum will be throbbing with beautiful booths, humming with activity, and the thousands of ambitious visitors who sweep through it each day will be inspired to take up one of the many attractive vocations that will be offered."

The United States government departments will make interesting exhibits showing the vocational trades taught the boys in the army and navy, as well as the civil service work in handling United States mails.

It is expected that welding demonstrations will be a feature of some of the exhibits. *The Welding Engineer* and *The Welding Encyclopedia* will occupy Booth 36 at the exposition.

G. O. CARTER TELLS PURCHASING AGENTS ABOUT WELDING

On March 20th, G. O. Carter, of the Linde Air Products Co., read a paper entitled "Business Men's Interest in Oxy-Acetylene Processes" before the Cincinnati Purchasing Agents' Association. In this paper he directed attention to the economies affected by oxy-acetylene, enabling factories to make new and better products. Special attention was directed to the great saving in time involved in using the oxy-acetylene cutting torch for dismantling machinery as well as for cutting out metal parts. As an example of the possibilities of oxy-acetylene welding, the great savings incident to the application of welding in the laying of oil carrying pipe lines was cited. Mr. Carter also pointed out that business men should also be interested in the welding of steam lines, both on account of the elimination of leaks at flanges and on account of the better insulation of pipe when the flanges were eliminated. He showed that on all kinds of pipe work and tank work, greater efficiency is secured by specified welded construction because the pipes and tanks last longer and are not so subject to leakage. The reclamation of broken parts in all kinds of machinery and structures, and the use of the welding torch on production work were also explained carefully.

ROBERT B. DYAR

With deep sorrow we announce the death of Robert B. Dyar, Chicago, Ill., on May 14, 1923. Mr. Dyar has been identified with the oxy-acetylene welding industry in the middle west for a number of years, first as a salesman of apparatus and later as an independent dealer. He was a friend to all those in the trade who knew him, and was held in high esteem for his ability and fine personal qualities.

LOCOMOTIVE FRAME WELDING

(Continued from Page 20)

It is the general practice in our shop to use three welders on all frames ranging in size from 3 in. by 4 in. to 5 in. by 6 in. and four men on all frames larger than the above mentioned. In so doing we find by alternating the welders every twenty or thirty minutes, none of them are tired out by having to stay on the job without necessary relief. This particular item is very important, and should be taken in consideration on every frame weld. It is impossible for a welder to perform his duties properly if he is required to stay on a frame and work any long period of time.

To give a fair idea of some of the frame welds we make in our shops, illustration 2 shows a main jaw inserted in a frame, this replacement requires four welds, such replacements mean a considerable saving against the setting in a new frame.

Illustrations 3-4-5 and 6 shows the welding of a locomotive frame which was formally an E2A type, but later were superheated, and inasmuch as the frames of the locomotive were not changed accordingly, they were found too light for the increased power.

The solution to this problem was to build heavier front sections, and weld them to the remaining rear sections thereby saving the changing of the trailer rigging, and a good deal of machine work.

These welds are made at a point just ahead of the fire box, and one familiar with the construction of such locomotives can realize the importance of an absolutely sound weld. You will note by illustrations 3 and 4 one weld in its making, and three to finish. You will also note in illustration 5 the four welds completed, with a very neat finish. Illustration 6 shows the side view of the frame when completed giving a general idea of the possibility in Locomotive Frame Welding.

FENDER WELDING

(Continued from Page 22)

it paid to remove any extra dents that appeared in a fender and charging the customer for so doing. The reason for my smile was not because of the extra charge, but simply because the more I travel, the more I find it true that when a job is brought to a welding shop, regardless of whether it is a fender or a steam boiler that has entirely played its part, and is completely worn out, the public expects the welder to say the magic word "PRESTO" and wave his welding torch in a manner known only to himself and the object is completely restored to its youth. Isn't that just about right, Ed?

I am working South from here and expect to be calling on some mighty good shops within the next week or two, so I will no doubt have a good snappy story for you the next time I write.

With kindest regards, I remain

As ever,

Shep.

Willard Foster, president of the Tulsa Oxy-Hydro Co., Tulsa, Okla., made a business trip to Chicago early in May, together with G. R. McCullough, treasurer of the company, and W. L. Kistler, vice-president. Mr. McCullough is president of the First National Bank of Tulsa, and Mr. Kistler is also a prominent business man in that city. The officers of the Tulsa Oxy-Hydro Co. are keenly interested in the rapid development of oxy-acetylene welding in the oil fields, and indicate that there is considerable promise of further expansion of the process there.

PRIZE WELDING STORIES

Welding Lug on Cylinder Jacket in Place—Welding Repair on 13 Foot Cast Iron Gear—Brazing Rotors

MARCH PRIZE STORIES

The following three stories have been selected from those submitted in response to our advertisement published in the March issue of THE WELDING ENGINEER. This concludes the series of prize welding stories. In all cases the awards have been made on the basis of the practical value of the instruction contained in the story, from the point of view of the man who desires to accomplish a similar job.

First Prize

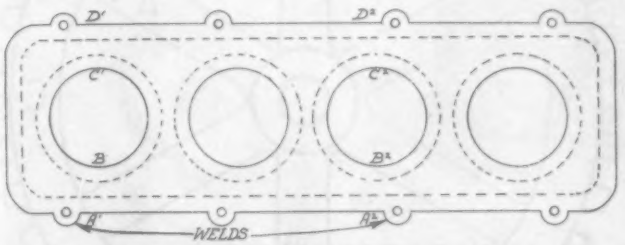
WELDING LUG ON CYLINDER JACKET IN PLACE

H. S. Lansing, Illinois

Some time ago we had a call to weld two lugs on the side of a Durant cylinder jacket without removing from car. A top view of block will show where welds were. (See sketch.)

As all we do is acetylene welding, we at first told the customer that it was impossible. But he insisted that it was going to be too big an expense to remove it, so we got to figuring whether we couldn't handle the expansion all right and decided we could. We told him before we started that we would guarantee the job, and to date the job is holding O. K.

We used one torch for heating and a separate one for welding.



Lugs at "A" Were Built on Without Removing from Car.

We commenced by warming block at "A" practically the full height of the water jacket. When wall "A" was warmed to about 200 degrees (our only thermometer was our judgment) we played the torch part of the time on wall "B." After continuing this process until "B" was at about 450 to 500 degrees and "A" was at 650 to 700 degrees then we commenced adding heat at "C." After raising all three about 150 degrees more, we included "D" in the operation. When "A" was at a red heat, the second torch was used for welding the lug, the first torch maintaining the desired temperature. At this stage of the game, for our own information, we put a straight edge across the machined top of the block which the head rests on. It showed the block to be over ⅛ inch higher in the center on the hot side, and about ⅛ inch higher on the side that was just warmed. The torch used for welding was then shut off, and the temperatures were backed up in the reverse order to which they were raised, the torch being used about 20 minutes and the jacket then covered with asbestos. After the first weld was thoroughly cool, the operation was repeated for the second lug. When the second lug had cooled, we used the straight edge again and found the upper surface straight as before welding.

We are not anxious for more of them, but we wanted to KNOW if it could be done. We believed it could be, and we did it. The only thing that convinced us that it wasn't altogether luck, was the fact that there were two of them. If we were to use our welder's privilege of broadcasting advice, it would be "Don't try this unless you absolutely KNOW cast iron temperatures and expansion."

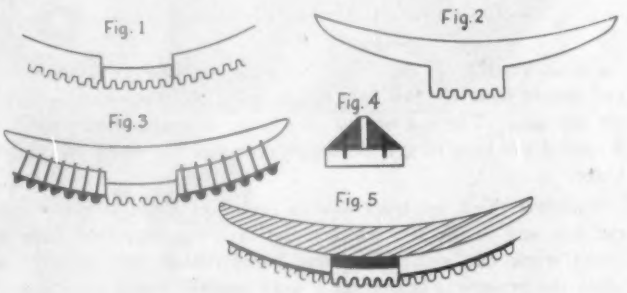
Second Prize

WELDING REPAIR ON A 13 FT. CAST IRON GEAR

By R. L. Moore, Pennsylvania

An arc welding job that saved considerable time and money was executed by the writer in Philadelphia two years ago.

The article welded was a cast iron gear 13 feet in diameter, meshing with a small drive gear. The large gear was on the main shaft of a punch press which pressed out nuts from bars 3½x2½ inches. Every time this machine pressed a nut from a bar, the same teeth of the large gear were in mesh with the small one. The strain always being at this one point, six teeth were broken from the large gear.



Details of Gear Repair.

The mechanical department at this plant made a steel plate with six teeth on and cut away about an inch of the cast iron where the teeth were broken out of the large gear and bolted the plate in place. When the machine was again put in operation, the remaining cast iron that the plate was bolted fast to, gave way. Then a welding concern was called on. Three welding firms turned the job down as the gear could not be preheated without being taken off the machine. The firm owning the punch press wanted the gear welded without being removed from the shaft as it would entail more expense to remove it than to purchase a new gear. At this stage I was called on the job.

I took the cutting torch and cut away the remaining cast iron over the steel plate with the teeth on as in Fig. 1. I then secured sixty ⅝-inch steel studs 3 inches long, drilled and tapped two holes 2 inches deep in each tooth for a distance of 3 feet on each side of the break and then placed the studs in the holes, after which I took a steel plate 1 inch thick and cut out a section the shape of Fig. 2 and placed it in position as in Fig. 3 after which I was ready for welding.

I then welded the plate I had cut out with the torch to the steel studs and to the section of steel plate with the teeth on. Fig. 4 represents a cross section of the gear after welding. Fig. 5 shows the finished weld from a side view. This job I know is still in successful operation.

Third Prize

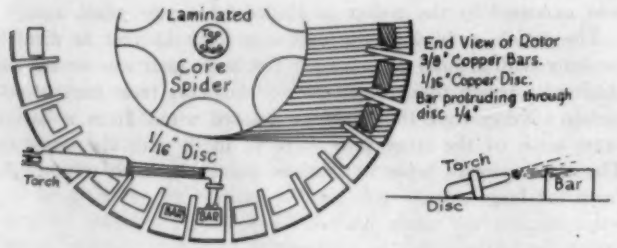
BRAZING ROTORS

By Joseph Heaton, Jr., Michigan

An oxy-acetylene welder in an electric motor repair shop has to weld all types of A. C. motor rotors. The idea of welding a rotor is to have a perfect electrical circuit through all the bars. Some types of these when manufactured are soldered and were soldered when repaired (that was before repair shops started to weld them).

But the motors run hot from various troubles and melt out this solder and cause what is electrically termed an open rotor. So the welding does away with any further trouble of this kind by making a solid job with high-melting-point metal, such as copper, brass or bronze. I always use soft brass wire and braze.

Quite a problem of torch and flame manipulation for me was a large 30 horsepower high-frequency motor rotor with a ⅜-inch square large heavy copper bar, with a light ⅛-inch disc to weld to. If I played the flame on top of the bar endwise (using a No. 6 tip) the flame that went over the edges would blow through



Showing Position of Torch for Welding Rotors.

the disc, then I couldn't have a bridge to weld to between bars and would have to take time to puddle or pile up enough brass to fill the gap. The reason for the large tips and flame was that I needed the heat to get the copper bar red hot so as to take the braze.

The first thing we tried was to pack wet sheet asbestos under the disc and in the slot between the bars, but that took time and didn't work out well; the flame honeycombed the asbestos and when the brass was brazed on it went into the wet porous asbestos and looked like a sponge when cool and was electrically imperfect.

Then I tried laying the torch flat on the disc inside of bar flame striking top of bar (as per sketch) that is, the elbow of torch resting on disc and end of tip raised as shown in the small sketch.

As soon as the bar was cherry red I brazed the bar and disc outside, then quickly reversed the torch, playing on outside of bar flame towards inside of rotor; then you see I had enough metal to back up my braze so I went onto the next bar and it brazed back to the last one. I always allowed as much brass to puddle as possible without running over edge of disc, and used ¼-inch soft brass wire on this job.

After I had a good brazed bed, or background I put on enough brass to level it up to top of bar, so when the welding job was completed and cooled I put it in a lathe turning off all excess brass, leaving a solid ⅜-inch square ring around top linking up all the bars solid.

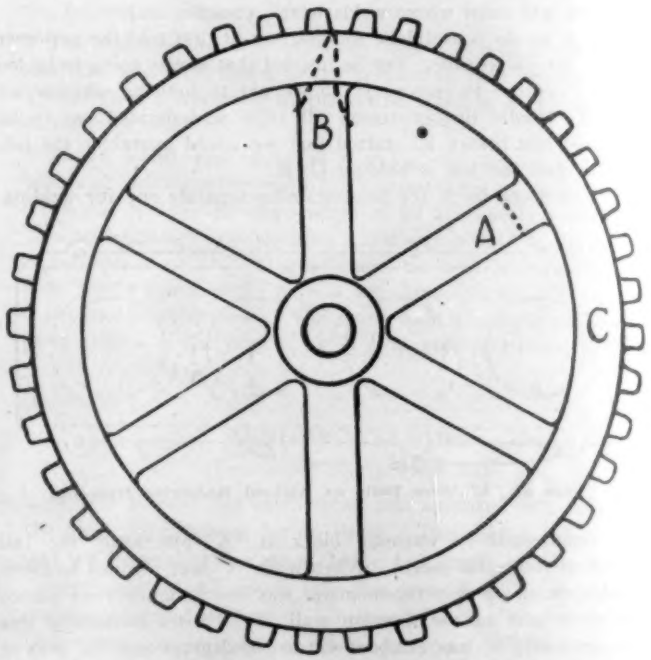
WELDING A CAST IRON GEAR WHEEL

By Geo. Reed

While working for a lumbering outfit as welder and machinist, my foreman received a wire from the captain of a boat plying on the Ottawa River in the freight business, asking for a welder and machinist to weld a cast iron gear wheel 42 in. x 5 in. face.

On the instructions given me I packed what accessories I thought would be necessary, and along with a helper started off to meet a small motor boat that was to take us to the job. Upon our arrival the engineer had the gear wheel out on a beach in the bay. A tent had been set up and a fire lighted. Men were making journeys back and forth to the boat which was out in deeper water, and it was about six P. M. when we landed on the job to find that this gear wheel was broken in two places. One place was very badly "sprung." To weld this gear successfully, without any means to preheat, was quite a problem. However, we decided we would weld it "cold." Having thus decided, we got two short logs and laid the gear flat upon them in such a way that the six "arms" could be made solid by small wooden wedges which are easy to make. One arm of the gear was broken clean through at "A" and another arm and the rim also at "B" had sprung outwardly. We made these two arms solid on the logs with wedges and chipped a "V" along the line of each break, and then reversed it and did the same thing there. By this time it was too dark to start any more work, and another reason for not going ahead was that I never like to rush on a job as I have found that it pays to go about a welding job thoughtfully and carefully. By so doing unfavorable circumstances are reduced to a minimum. We piled our tools, etc., around the wheel and covered it over with a canvass in case of rain during the night.

Before going to sleep I tried to figure out how I was to get the "sprung" part of the gear at "B" back into place, and the next morning this is what we did. We stood the wheel up and put a steel strap through the bore in the hub and another one on top of the rim at "B," then passing a ⅞-in. bolt through the straps, one on each side, we tightened up while the helper heated the rim at "C" with the torch, with the result that the rim came back into place nicely.



Badly Sprung Spoke Made this Weld Difficult.

The next thing to do was to make a bed of loose sand, of which there was plenty, and lay the gear flat down on it with the steel straps still in place. We piled sand all over about 6 in. deep above the gear, except at each break where I left a space about as large as a football so that I could work the torch. In this sand and in several places we made funnel-like holes into which the helper constantly poured cold water to prevent heat radiation, and, consequently, expansion, which we wished to avoid. A thorough, good weld was made on this side, and we then removed some of the sand and poured water as near the weld as practical until it was well cooled off, after which the straps were removed and the same method of procedure followed on the other side.

This gear, I am told, is still in active use, and while I am willing to admit that it likely made a hard weld or set up stresses somewhere, it was a case where one had to depart from conventional methods and take a chance.

The office of the Acme Oxygen Company, formerly located at 431 South Dearborn St., Chicago, has been moved to new quarters at Pershing Road and Racine Ave.

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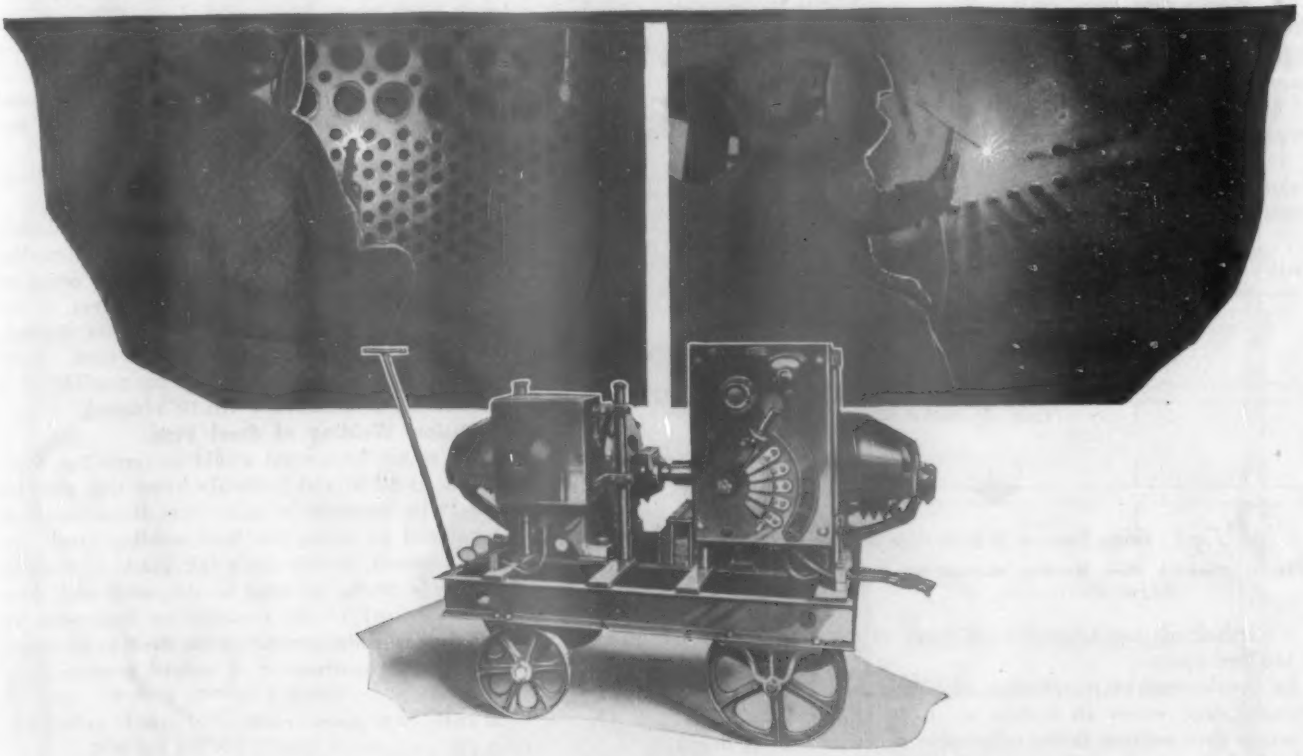

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43B-714

AMMONIA PIPE LINES AND COILS*

Design of Welded Pipe Fittings — Relative Merits of Welded Joints and Fittings—Pipe Welding Procedure

By C. Wilkie

THIS paper is confined to the subject of welding ammonia pipe lines, coils and pressure vessels in ice making and cold storage plants.

The design of welded pipe fittings, ammonia receivers, oil separators and coils are touched upon.

The composition of pipe and welding wire is discussed and suggestions made as to welding conditions.

In considering the relative merits of welded and flanged joints in pipe lines and coils a specific instance is cited to show the superiority of the former.

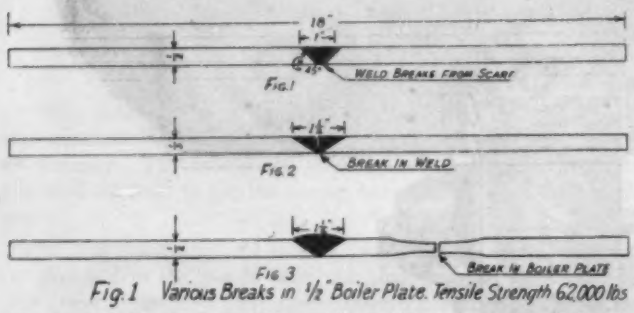

Fig. 1 Various Breaks in ½" Boiler Plate. Tensile Strength 62,000 lbs

Fig. 1. Showing How Welding Method Affects Strength of Weld.

A method of increasing the efficiency of the single V weld is touched upon.

In considering an installation of piping for an ice or cold storage plant, where all fittings are to be eliminated entirely, it seems that welding is the only other practical way of doing this class of work, but, however, welding has not been accepted generally as the most satisfactory method of joining steel pipe together under all conditions.

There are probably several reasons for this.

1st. The success of welding seems to be too much dependent upon the personal equation.

2nd. There being no satisfactory method known at the present time of inspecting welds after they are made.

3rd. The scarcity of first-class pipe welders for high pressure work.

4th. The scarcity of engineers in charge of plants who have the ambition to get the necessary knowledge required to complete an installation of welded piping.

In the past few years, however, welding has been employed to some extent in plants, particularly in low pressure line and coil installations, and a few plants have welded ammonia condensers and discharge lines, which have all proven satisfactory.

The Advantages of Welded Pipe Lines and Coils

In welded pipe lines and coils the use of expensive fittings is eliminated which greatly reduces the first cost of an installation.

The life of the pipe lines and coils is increased from 20 to 50 per cent. This is especially true in small pipe, where 40 to 50 per cent of the metal involved is cut away by threading, and the fact that there is two or three threads exposed behind each fitting at which point the first leak usually appears.

It is customary to use hair-pin bends made up from 1¼ in. standard pipe with 4½ in. and 5 in. centers in ice freezing tanks; the thickness of the pipe wall on the back of these bends is reduced from 40 to 60 per cent, depending upon the nature of the heat. This defect can be overcome by the use of welded return bends which will cost less than fittings.

The extremely low cost of maintenance on welded lines and coils is reduced to a minimum, for when once in position and welded, there are no repairs to be made.

Welded lines can be installed in less time than where fittings are used, and very much cheaper.

Another interesting saving effected in welded lines and coils is that of ammonia consumption. For instance, an installation of piping that would require 10,000 welds in order to eliminate all thread and gasket joints would, however, at the same time eliminate from 30,000 to 40,000 leak points, depending upon the number of different types of fittings used. With the leak points eliminated, or as nearly so as possible, it is clear that the ammonia consumption will be reduced.

Fusion Welding of Steel Pipe

In steel pipe we do not have what would be termed as first-class welding steel, as all of you probably know that pipe up to and including 12 in. diameter is made from Bessemer steel and is not recognized as being the best welding steel. In large O. D. pipe, however, we do get a fair grade of welding steel, as this pipe is made of open-hearth steel and does correspond (or nearly so) to the composition suggested by the A. S. M. E. boiler code committee in their preliminary report on rules for the construction of unfired pressure vessels.

The chemical analysis of open-hearth steel pipe is as follows:

Carbon	.11 to .15%
Phosphorus not over	.04%
Sulphur not over	.05%
Manganese not over	.60%

Pipe of this composition would have about the following physical characteristics:

Tensile strength	45,000 to 55,000 lbs. per sq. in.
Elastic limit	½ of Tensile Strength
Elongation in 8 in.	22%
Reduction in area	50%

The chemical analysis of steel pipe furnished in Bessemer steel is as follows:

Carbon	.08 to .12%
Phosphorus	.100%
Sulphur	.06%
Manganese	.50%

The physical characteristics are as follows:

Tensile strength	50,000 to 60,000 lbs. per sq. in.
Elastic limit	½ of Tensile Strength
Elongation in 8 in.	20%
Reduction in area	50%

You will note the carbon content in the open hearth steel is higher than in the Bessemer steel and yet the former has a lower tensile strength.

The difference in carbon is probably not enough to affect the tensile strength to any great extent, as in low carbon steel, say from .08 to .15 per cent, it seems that the tensile strength is affected very little.

The Bessemer steel being higher in tensile strength is probably due to the process of manufacturing, and the fact that the phosphorus and sulphur content is higher, which tends to harden the metal and increase the tensile strength. The hardness of the pipe, however, makes thread cutting easier

Paper read before The American Society of Refrigerating Engineers, St. Louis, Mo., May 2, 1923.

THE VALVE OF A

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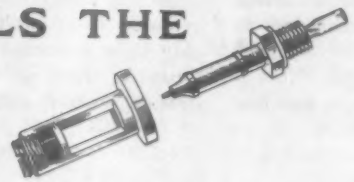

If the control is faulty the whole welding and cutting system suffers.

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and decreases the ductility about the same as increased carbon content within certain limits.

It is clear that pipe furnished in open hearth steel would be more suitable for welding than that furnished in Bessemer, because the former is softer, tougher, more ductile and does contain less phosphorus and sulphur and will stand a more severe treatment either mechanical or by heat. I have been informed that open-hearth steel pipe can be had in sizes from 1¼ in. to 2 in. if purchased in large quantities. Pipe with a tensile strength of 45,000 to 55,000 lbs. per sq. in. would serve satisfactorily its purpose in ice and cold storage plants, as about three-fourths of it is used for low pressure ammonia and brine, while the remaining 25 per cent is subjected to condenser pressure, and with the exception of the condenser coils proper, extra heavy pipe is usually employed.

However, if the tensile strength of the pipe was too low for certain purposes, a heavier wall could be had with the same tensile strength per sq. in.

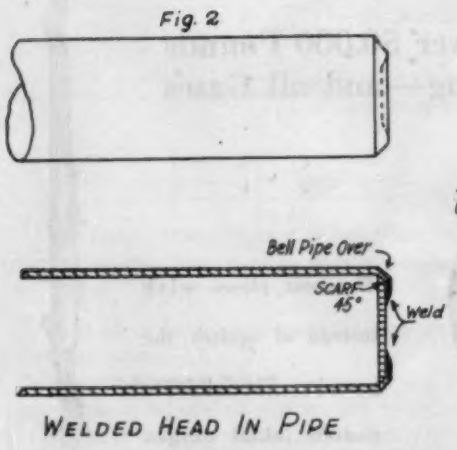


Fig. 2. This Design Makes a Strong Job.

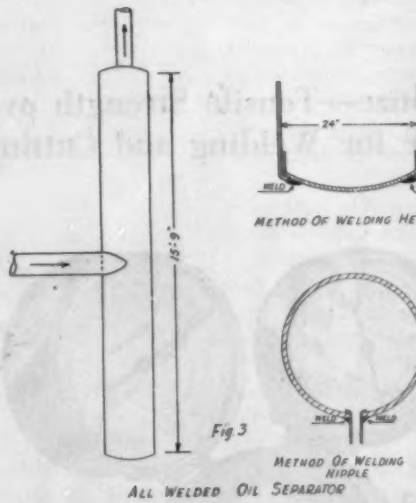


Fig. 3. The Intake on the Separator Tank Makes a Tangent Connection.

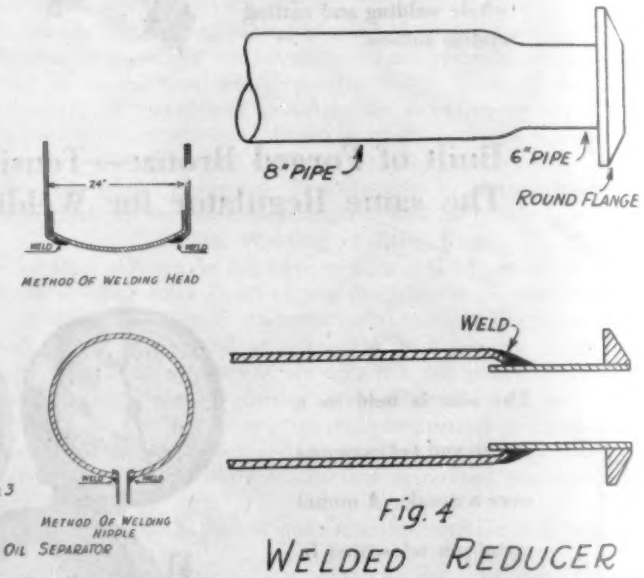


Fig. 4. Special Parts Like This Can Be Made Quickly With the Torch.

Welding Metal for Fusion Welding of Steel Pipe

In selecting welding wire to be used in welding steel pipe for ammonia or any other such gases, is a question that is, in my opinion, very important for the simple reason that we must have

1st. An absolute nonporous weld.
2nd. A weld that is properly fused.
3rd. Tensile strength in the weld.
4th. Ductility.

Welding wire can be had that will give from 40,000 to 62,000 lbs. tensile strength in a single V weld made in ½ in. plate.

The following is the analysis of five different grades of welding wire, namely:

A, B, C, D and E Wire

	"A"	"B"	"C"	"D"	"E"
	%	%	%	%	%
Carbon	.049	.05	.08 to .10	.08 to .10	.20 to .24
Phosphorus	.025	.01	.01	.03	.04
Sulphur	.04	.025	.025	.03	.04
Manganese	.21	.20	.45	.30	.65
Nickel	—	—	—	—	3.5

A weld made with wire "A" would have a tensile strength of about 40,000 lbs. per sq. in. in the weld made in ½ in. plate, and the weld could be made nonporous, properly fused, tensile strength at the minimum, and ductility at the maximum.

A weld made with wire "E", which is high in carbon and contains 3.5 per cent of nickel steel, would have a tensile strength of about 62,000 lbs. per sq. in. The weld could be made nonporous, properly fused, the tensile strength would be at the maximum, and ductility at the minimum. After comparing the extremely high carbon wire and the extremely low carbon, it does not seem possible to get what we desire with either wire, especially from the high carbon (or wire "E"), but, however, we could probably get the desired tensile strength with the low carbon (or wire "A" by reinforcing the weld, say 30 to 40 per cent. This, of course, would be undesirable, due to the fact that it would add to the cost of the weld considerably, not that the wire would be overly expensive, but the welders' time and the extra gas that would be consumed in adding the additional metal, would be expensive.

On the other hand, a pipe weld made with the "E" wire, properly fused, and reinforced say 10 per cent, would probably have a strength great enough to resist any line stresses throwing them into the pipe itself which is lower in tensile strength, softer, and, of course, more ductile.

Wire "B" has a tensile strength of 46,000 lbs. per sq. in. in the weld, wire "C" about 52,000, and wire "D" 54,000 lbs. per sq. in. I would suggest using a wire of about the same composition as "D".

There are three reasons for this:

1st. By reinforcing the weld say 10 to 15 per cent, its margin of strength above that of steel pipe would be sufficient to throw the strain into the pipe because of the latter's ductility, and the weld would probably never be stressed beyond a safe point.

2nd. Porosity is much easier overcome with this wire than where the nickel (or wire "E") is used, due to the fact that it will flow freely, and as it contains less carbon, it will naturally stand a more severe treatment by heat. In other words, the metal can be overheated a certain degree and yet the weld will not be porous.

3rd. It being a grade of wire that most welders are familiar with. The nickel steel (or wire "E") is overheated, the weld will be porous, but, however, the tensile strength will probably not be reduced below a safe point; it all depends upon the cause of the defect. Therefore, it is impossible to say to what extent the quality of the weld has been reduced if porous.

Weld metal, like any other steel, is not a noncorrosive metal by any means, and the nickel wire for wire ("E") has its advantage in this respect. All of you probably know that pipe located on the roof of an ice or cold storage plant, as a rule, has a shorter life than any pipe in the plant, as it is not possible to give it the proper protection from moisture which exists in connection with cooling-towers and spray ponds. It is a common thing to see from 1/16 to ⅛ in. of rust on a pipe line that is exposed to roof conditions.

Three specimens cut from steel pipe of ¼ in. walls were welded with wires "C", "D" and "E", and were exposed to conditions as mentioned above for one year. The reduction in area of the base metal due to corrosion averaged 1.2 per cent. The reduction in area of the weld made with wire "C" was 3.8 per cent, that of weld "D" was 3.2 per cent, and the reduction in area of the weld made with wire "E" was only 1.4 per cent, or .2 per cent more than the base metal.

However, the reduction in pipe area would not be as great, as there would only be one side of the metal exposed to the moisture. The object of making the test was to get some idea of the rust resistant qualities of the weld metal, and they were only comparative tests.

Preparing Pipe for Welding

It is just as important to prepare pipe for welding as it is to weld it together. And this is a factor that seems to be overlooked in a great many cases. In making the necessary preparations for welding it is necessary to bevel or scarf all standard pipe above 2 in. and all extra heavy pipe above 1½ in. The scarfing can be done with the cutting torch by laying the cutting tip on the pipe at the proper angle so as to leave the metal at the bottom of the scarf about ⅛ in. thick. The scarf should be about 1½ times the thickness of the metal (See Fig. 1), because a 45 degree scarf doesn't seem to give enough fusion area in the base metal. I don't mean to say that a 100 per cent weld can't be made where the metal is scarfed at 45 degrees. It can be made, but with the average welder it is found that a certain per cent of specimens when tested will break along the line of the scarf. To overcome this defect it is necessary to make the scarf at a higher degree in order to get more fusion area. Then, however, the weld will break in the center. To overcome this defect it is necessary to reiniforce the weld by building it up, or use an alloy such as the nickel steel. In welding pipe together care should be taken in cutting so as to get the ends square—a greater opening on one side will cause an uneven shrinkage and the pipe will not be straight. This is very important in welding large pipe where a considerable amount of metal is involved.

In making preparations for welding heads in pipe, traps, oil separators and receivers, small pipe where flat heads are used, the head plate should be scarfed at 45 degrees around the edge and placed inside the pipe and the proper distance so that 1½ times the thickness of the pipe wall can be crimped over onto the head plate, and weld to seal the joint. (See Fig. 2.)

For standard bumped heads they can be placed inside the pipe and welded in the same manner as the flat heads (See Fig. 3), or have the diameter of the heads made the same as that of pipe and make butt welds.

In making reducers it is necessary to crimp the larger pipe, afterwards inserting the smaller pipe or nipple. This fitting is the most expensive of all to make, as it is necessary to make a very wide weld in order to get the desired thickness at the center. (See Fig. 4.)

90-degree elbows are very simple fittings to make, there being two 45-degree welds. The length of the center piece on the inside is equal to one-half the diameter of the pipe, so that all elbows are of a uniform size. (See Fig. 5.)

Tees are made by first cutting the nipple to a saddle form to fit the pipe. The nipple then serves as a pattern for marking off the hole. After cutting the hole it is scarfed to 45 degrees on the sides and two times the thickness of the metal on top of the pipe. Patterns are used for laying out tees and elbows and a perfect fit is obtained without doing any trimming. (See Fig. 6.)

Where welded elbows or tees are made in close work with flanges and the fittings are not a true 90 degree, it is an easy matter to face the flanges by heating a ring around the pipe a short distance away from the flange and then tighten up the bolts. (See Fig. 7.)

In making welded return-bends the pipe and two return pieces are sawed at the proper angle, and three 60-degree welds are required to complete the half circle.

There are several advantages in the welded return-bend.

1st. A more compact coil can be had without thread joints, as 2¼ in. centers can be obtained with 1¼ in. pipe and 3 in. centers with 2 in. pipe.

2nd. The pump head is reduced about 30 per cent in the height of the coil.

3rd. The thickness of the metal in the back of the bend is not reduced.

4th. Drip-strips are eliminated due to close pipe centers or proper centers.

5th. Welded beads cost less than screwed fittings.

6th. The life of the coil is dependent on the life of the pipe and not on a thread joint.

7th. A defective pipe can be renewed without taking the coil apart. (See Fig. 8.)

The Efficiency of Welded Pipe Joints

There has been, in the past few years, a great deal of thought given to the subject of efficiency of welded joints; that is, the ratio of the weld itself to the base-metal. It is true that in job welding shops and a number of established manufacturing plants, efficiency is all that is desired, but, however, as we are discussing the subject of welded ammonia pipe lines, it seems that we should speak in terms of quality as it is possible to make a 100 per cent, or probably a 135 per cent, weld as far as efficiency is concerned, and yet it will leak ammonia gas. I might relate some experience that will prove this theory. An ammonia accumulator made up from ½ in. steel plate and welded throughout, and tested at 300 lbs. water pressure and did not leak, but did leak with 25 lbs. of ammonia gas.

It is clear that leaks do not indicate low efficiency. Anyone with the proper knowledge of welding steel can melt into a defective weld and afterwards state the exact cause of the leak. As a rule there are four reasons for a leaky weld:

First—The lack of fusion of the metal involved.

Second—Oxidation or an excess amount of oxygen is fed through the torch and mixes with all the acetylene available and the surplus oxygen attacks the metal.

When oxidizing a weld made in steel, foam or a scum will form on the metal and it will turn to a very white heat. An oxidized weld is porous, the tensile strength is reduced and it cannot be very ductile.

Third—Carbonization; that is, an excess amount of acetylene is fed through the torch, causing incomplete combustion.

You often hear welders speak of oxidized welds, but very seldom do they speak of carbonized welds, and from my experience I can safely say that 60 per cent of the leaks in ammonia pipe lines are caused by the welder using a slightly carbonized flame and about 20 per cent are due to improper fusion of the metal. The other 20 per cent is due to oxidizing and overheating. A carbonized weld is very porous and can be rewelded and the quality restored to some extent by using a lightly oxidizing flame.

Fourth—Practically all welders weld forward; that is, the flame follows the rod, and when welding pipe, especially small pipe, there is danger of overheating when the weld is near completion, and in case the weld is overheated at this point it will be porous and will leak. Overheating will sometimes cause the pipe to leak as far as ½ in. away from the weld. But, however, by welding backwards with the rod following the flame, and by slightly moving the rod, causing the metal to be agitated, which will overcome the porous effect caused by overheating, the weld will be compact and nonporous, but, of course, this method will not prevent the pipe from leaking due to overheating.

Some welders insist on making a smooth surfaced weld, that is, dressing the surface of the weld as it is completed, and in some cases, however, they are asked to do this. But from my

experience I would advise anyone to beware of such welds. A weld can be ever so porous and by melting into the surface, say $\frac{1}{16}$ in., with the proper flame in order to dress the weld, the chances are it will stand a high pressure test without showing any signs of leaking. The possibility of any leaks should be overcome with the first metal that is placed in a welded pipe joint, as it is possible to make a weld that would be 100 per cent efficient as far as tensile strength is concerned, and yet be porous to within $\frac{1}{16}$ in. or probably $\frac{1}{32}$ in. of the surface, and will in time leak due to corrosion. On the other hand where fittings are used the same thing can happen and does happen. The possibility of a thread joint not leaking may be depending upon one particular thread, and in the course of time, however, it will leak.

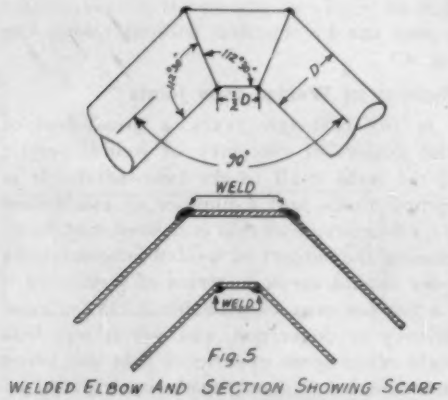
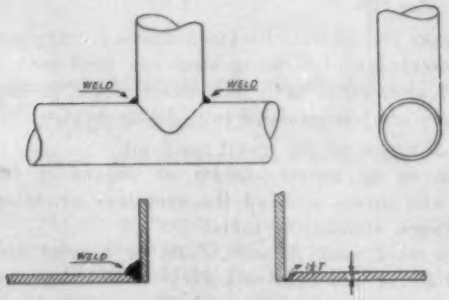


Fig. 5

WELDED ELBOW AND SECTION SHOWING SCARF

Fig. 5. This Joint Minimizes Friction and Restricted Areas.



WELDED TEE AND SECTION SHOWING SCARF

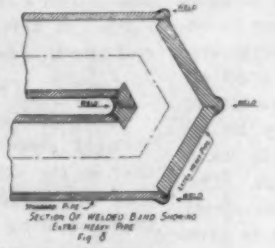
Fig 6

Fig. 6. Preparation of Tee-Weld.

As a rule in welding pipe which has a heavy wall, the average welder will get the most defective metal at the bottom of the weld. This is due to the fact that the sides of the V are broken down first, causing iron oxide to be washed to the bottom of the weld. Tests have shown that the tensile strength of the first $\frac{1}{8}$ in. or $\frac{3}{16}$ in. of metal in a weld made in this manner to be as low as 19,000 lbs. per sq. in., whereas the same area near the surface of the weld would have a tensile strength of 51,000 lbs. per sq. in.

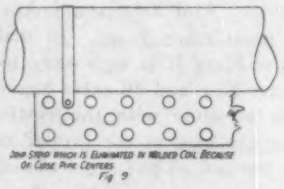
This defect can easily be overcome. Since the metal is $\frac{1}{8}$ in. thick at the bottom of the scarf, and the scarf is $1\frac{1}{2}$ times the thickness of the metal, it is clear that by melting through the metal (or nearly so) at the bottom of the V, and at the same time adding additional welding metal, that the bottom half of the weld would be as sound as the top half, and by welding the bottom of the V a distance of from 1 in. to $1\frac{1}{2}$ in., before the sides at the top are melted down, it is an easy matter then, providing the torch is properly handled, to wash practically all the iron oxide to the surface of the weld. This method alone will increase the efficiency of a single V weld from 8 to 12 per cent. A double V weld would evidently be more efficient than a single V, but in welding pipe it would be impossible to make a double V weld due to the small diameter of pipe used in ice making and cold storage plants.

The improper cleaning of the scarfs, providing this work is done with the cutting torch, will affect the quality of a weld. It is important to maintain a neutral flame while scarfing in order to eliminate, as nearly as possible, any carbonizing action on the surface of the metal. In welding small pipe, say, up to 2 in. in diameter, where scarfing is unnecessary, the weld should be made as rapidly as possible, providing the flame is of ample size to melt through the pipe wall in a reasonable length of time. When melting into the pipe the flame automatically scarfs the metal to $1\frac{1}{2}$ to 2 times its thickness, and by having the welding wire follow the flame it is an easy



SECTION OF WELDED BAND SHOWING EXTRA HEAVY PIPE

Fig 8



2nd STRIP WHICH IS ELIMINATED IN WELDED COIL BECAUSE OF CLOSE PIPE CENTERS.

Fig 9

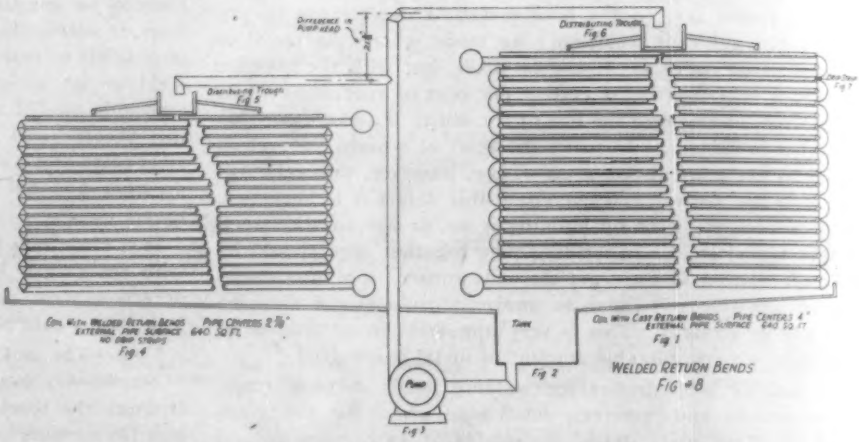


Fig. 8. Comparison of Welded and Cast Return Bends.

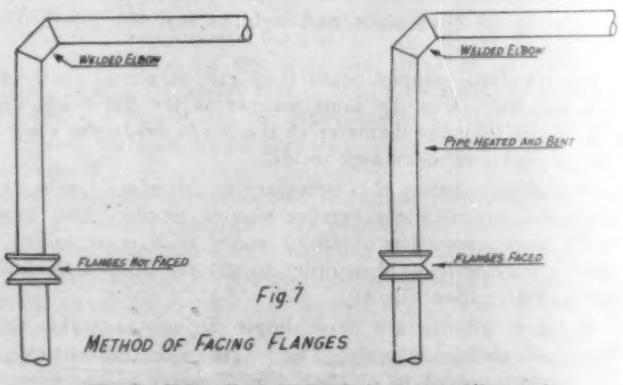


Fig. 7

METHOD OF FACING FLANGES

Fig. 7. Using Heat of Torch to Secure Alignment.

matter to tell when the pipe is welded through, as the bottom of the V, which is made by the flame, will become soft, which indicates that the metal is at the fusing point on the inner side, and the necessary amount of welding metal is added to reinforce the weld from 10 to 25 per cent, depending upon the composition of welding wire used.

Small pipe welds very seldom leak due to improper fusion of the metal. Since the flame melts practically through the pipe, it would be impossible not to get a thorough union of the metal. If the proper flame is used and the metal is not overheated, it is much easier to make 100 per cent welds in

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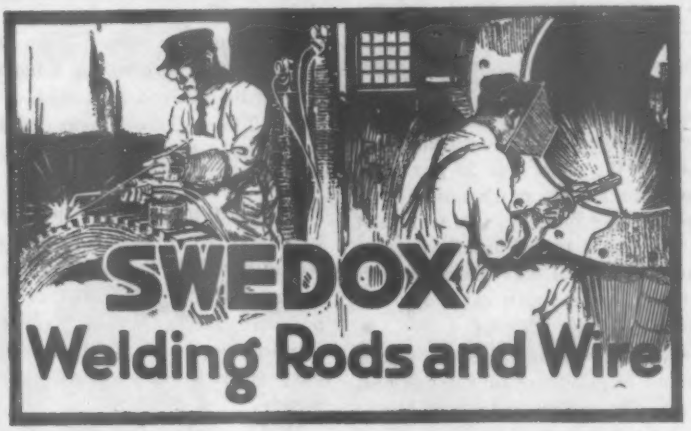

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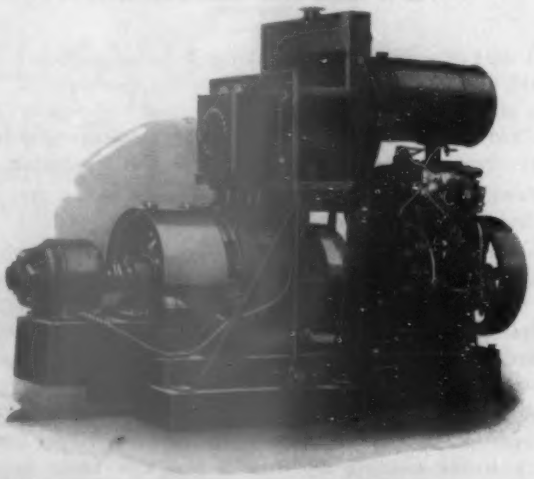

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small pipe than in large pipe with the single V weld. In fact, there is no excuse for a small pipe weld not being 100 per cent in every respect.

In comparative test, on flanged and welded joints in small pipe, it is clear that the latter is superior to the flanged joint. For example, a 1¼ in. pipe specimen 18 in. long, with a pair of standard oval flanges in the center, broke in the thread just behind the flange—the efficiency of the joint was 50 per cent. A like specimen was made up from 1¼ in. extra heavy pipe and the flange broke at 58 per cent efficiency. A weld cut from work being done in the plant was tested and broke 2½ in. away from the weld. A solid specimen was tested, which was cut from the same length of pipe in both cases for the purpose of calculating the efficiency. (See Fig. 9.)

Torches and regulators (or reducing valves, it seems, would be a more correct name for them) in poor working order will cause defective welds. The regulators or reducing valves cannot be depended upon for close regulation, and the so-called needle valves on the torches are far from perfection. Take most any torch of the present day design and there is sufficient lost motion in the threads on the valve stems to make the necessary adjustments by merely pressing in, or pulling out, on the stems with tips up to and including No. 5. In doing coil work, or working in close places, as must be done in plants, it is almost impossible to prevent striking these valves against some object which slightly changes the flame, causing a great many defective welds, and aside from this a

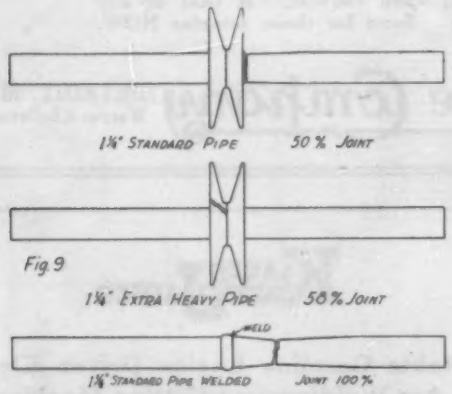

Fig. 9. Tests Show Welded Joints to be Superior.

great deal of time is lost in making flame adjustments. There should be more threads per inch on the valve stems. Torch valve stems with 30 threads per inch, and well fitted, will give excellent results with about 2 lbs. excess pressure on the hose to take care of pressure changes through the reducing valves.

Drawing acetylene gas from the cylinder at too great a rate will have a decided effect on the quality of a weld.

The inside of acetylene cylinders are filled with a substance, such as asbestos, which is saturated with acetone. This liquid will dissolve many times its own volume of acetylene gas. Considerable time is required for charging cylinders so that the acetone will dissolve the maximum quantity of acetylene. The time required for charging is about 48 hours.

The acetylene should never be withdrawn from the cylinder at a greater rate than one-seventh of its capacity per hour. In case a larger welding tip than a No. 8 is being used, two acetylene cylinders should be connected by means of a manifold, designed for the purpose, so that no single cylinder will be exhausted rapidly enough to draw off any acetone.

Relieving Welding Strains in Pipe Lines

In taking care of welding strains in pipe lines, there are two methods by which the work can at least be attempted.

1st. Where fittings are made in pipe lines in position, the strains can be relieved to some extent by heating a ring around the pipe on either side of the fitting. The width of the heat should not be, in any case, less than one-half the diameter of the pipe. There should be sufficient heat applied to bring the pipe up to a bending temperature, and the heat should be as even as possible the entire circumference of the pipe. The necessary heat can be applied from a welding torch, and if necessary two torches can be used.

2nd. Coal oil blow torches can be employed whereby the welded fitting proper is preheated to the proper temperature to relieve welding strains—a temperature of 1,050 degrees F. would probably be sufficient. (A. S. M. E. Boiler Code.) The fitting, including the weld, or welds, should be at an even temperature (or as nearly so as possible), and covered with asbestos paper or any insulating material that would serve the purpose in order to allow the fitting or welded joint to cool slowly.

Welds made in small pipe up to and including 1¼ in., as a rule, are made in from two to four minutes' time, and when completed the welded section is at the annealing temperature. In the case of very small pipe, say up to 1 in. standard, the welded section is at a higher temperature than is necessary for annealing. It is clear that welds made in small pipe would receive a fair degree of preheating from the torch, thus eliminating the necessity of annealing.

In regards to steel flanges that are screwed on the pipe and welded for the purpose of sealing the joint, I would say that,

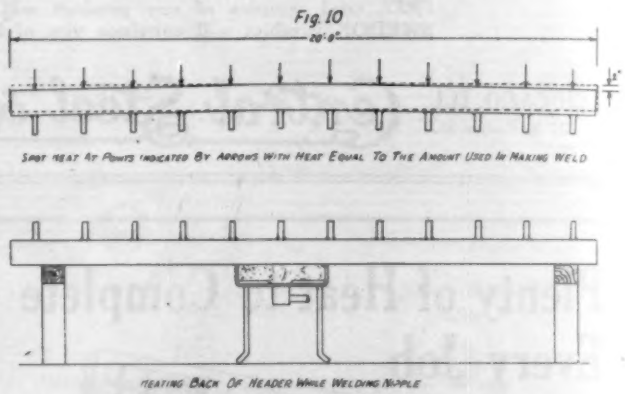
Fig. 10
20'-0"
Spot Heat At Points Indicated By Arrows With Heat Equal To The Amount Used In Making Weld
Heating Back Of Header While Welding Nipple
Nipples Welded In Header

Fig. 10. Avoiding Distortion when Welding Nipples. New Thermit, Double Burner, Rail Preheater.

of course, this would be satisfactory, and it would not be necessary to anneal the joints because the safety of the construction is not dependent upon the strength of the weld.

In considering the construction of ammonia receivers and oil separators, to be made up in plants, as a rule it is necessary to use pipe for the shells of such vessels. Ice and cold storage plants do not have the necessary equipment for rolling such shells, providing the longitudinal seams are welded, nor are they prepared to anneal any part of vessels made from pipe as large as 24 in. diameter. Standard bumped heads of the proper thickness and properly crimped in the pipe, and welded, would not require annealing.

The nipples for gauge cocks, and liquid in and outlet connections, can be screwed into the pipe and welded for sealing, or such nipples can be flanged and inserted from the inside before the heads are fitted. A vessel of this design would not require any annealing. Aside from this, the possibility of getting such vessels covered by insurance would be considered.

There are several methods by which long headers can be kept straight when it is necessary to weld in a number of nipples.

1st. Preheat the header in a forge fire as the nipples are being welded in. By this method, however, the labor cost is

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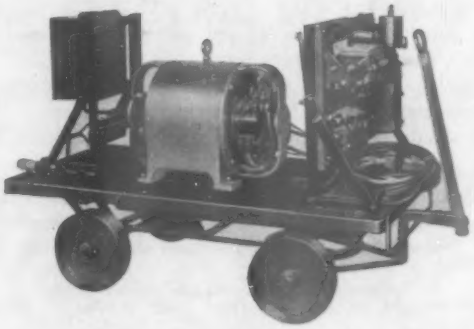

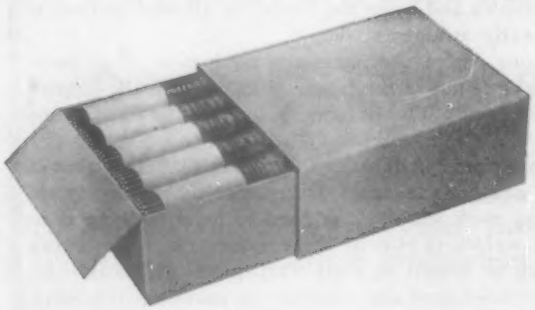

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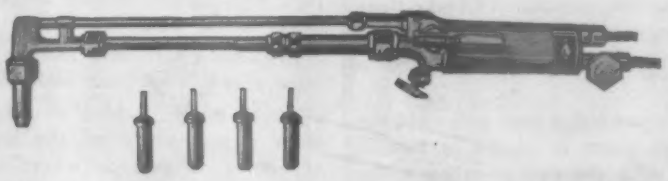

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considerable, due to the fact that it is necessary to furnish the welder with a helper, as care should be taken in keeping the header in a level position. Besides, the welder is compelled to stand over a forge fire which is not a pleasant thing to do.

2nd. Weld in all nipples, allowing the header to expand and contract at will. When the welding of all nipples is completed and the header allowed to cool, and it can be straightened very easily by turning upside down and with the welding torch spot heat just opposite each nipple that was welded, applying, as nearly as possible, the same heat that we applied when welding the nipples and after the header is allowed to cool it will be sufficiently straight.

3rd. In shops where the necessary equipment is at hand the proper curve is put in the pipe and in welding the nipples will, of course, cause the header to become straight. (See Fig. 10.)

The The principal qualifications of a man that is, or that is to become, a welder, is ingenuity. Ingenuity is absolutely required in doing such work. It is hard to believe that a man can become a welder in two or three weeks' time. It is true that a man can be taught to weld small pipe in a short time, providing he is intelligent and receives the proper instructions. But to enable a man to have a thorough knowledge of welding steel pipe, much more experience than three weeks, or even six months, is necessary. Most men can't grasp the necessary knowledge to be first-class welders. W ehave a great number of so-called welders, and I have found from past experience that it was not the fault of the man altogether. Some have had improper training; some have had very little, if any, training, and those that have had job-shop experience for any length of time seem to be far more successful when welding pipe.

An inexperienced man as a rule can be taught to weld pipe in less time than a welder that has been brazing or welding cast iron, and in time will make a much better welder. If a welder receives the proper training and is really interested in the profession, it is hard to believe that he would make defective welds. In my experience with probably 50 or 60 welders, I never knew of but one or two that were really careless. Any defects in pipe welds, as a rule, were due to the lack of knowledge. There are welders that are condemned today for some defect that was made through ignorance, and the probabilities are, if the man could have received the proper training for a few weeks, he would have been an expert at the art.

In some localities we find any number of first-class welders, and in other sections it seems impossible to find one. It appears that the knowledge of these men could be utilized to a better advantage if they were placed in a position where they could convey at least some of their useful knowledge to others that are not so fortunate.

Any engineer in charge of a plant should have a thorough knowledge of welding steel pipe. As a rule, where welders are employed in plants, the engineer is compelled to take their advice. This is especially true in small plants.

Welding steel pipe in ice and cold storage plants is not a fad, but a necessity.

Any engineer with the proper knowledge who will weld the entire installation of piping in his plant, or plants, or have it welded, eliminating all fittings with the exception of where valves are bolted in (and in this case the flanges should be welded to the pipe), will without a doubt save his company considerable money, not only in first cost, but the savings in ammonia, maintenance and the decreased depreciation of the installation will be appreciated I am sure.

The Requirements of a First Class Pipe Welder

1st—A welder should be ingenious and he must be honest.

2nd—A welder should have a thorough knowledge of the composition of steel pipe.

3rd—He should be able to select the proper welding wire to be used.

4th—He should experience the testing of welded specimens made with oxydizing, carbonizing, and neutral flame. High pressure air, tensile, and bending test should be made on such specimens to determine the extent to which a weld can be carbonized or oxydized without decreasing the quality beyond a safe point.

5th—A welder should be able to make a 100 per cent weld on pipe in a vertical or horizontal position.

6th—He should be able to select the proper size welding tip for any given size pipe.

7th—He should be able to lay out patterns to be used in cutting out tees, elbows and return bends.

8th—A welder should be well versed as to the construction of at least three makes of the leading welding equipment.

9th—He should be able to keep his helper, or helpers, busy at all times.

10th—A welder should have a thorough knowledge of taking care of welding strains in pipe lines, and furthermore he should know the few methods by which strains are prevented to some extent.

11th—He should be able to read blue prints of prospective pipe installations.

12th—A welder should have a thorough knowledge of estimating the quantity of acetylene and oxygen consumed in doing any particular piece of work.

DISCUSSION*

Q. When welds in pipe joints were tested, did the breaks occur far enough from the joint to indicate that the metal in the vicinity of the weld had not been weakened by the heat of the flame?

A. In testing over 200 1¼" pipe specimens, the specimens did break in every case from 2½" to 3" away from the weld. or about half way between the weld and the jaw of the machine.

Q. Is the life of welded pipes in service long enough so that the cost of replacing worn-out sections by the oxy-acetylene process, i. e., by cutting out corroded sections with a torch and replacing them with a torch, would still be cheaper than the cost of making ordinary replacements where fittings are used?

A. Cutting out sections and replacing with a torch is very much cheaper than doing such work where fittings are used. Ammonia fittings have to be heated in order to get them loose on the thread and as a rule the section is taken to a forge in order to get the fitting off, then the flanges are made up on the new section which is bolted in place. One man can cut out a section as quickly as probably four men could take the bolts out of a section.

Q. In cases where nippers are screwed into the pipe and welded for sealing, how does the strength of the joint compare with the joint which could be made by welding the nipple direct to the pipe?

In cases where such sealing is done, is the strength of the joint a very important matter?

A. A nipple welded directly to the vessel or pipe, if the work is properly done, the joint will be just as strong and of course as safe as where the nipple is screwed in and welded for sealing. I don't recommend screwing nipples into headers or pipes, but however, where insurance is desired on vessels such as ammonia receivers and oil separators it is necessary to screw such nipples in, in order to get insurance.

Q. Referring to the first method suggested for relieving welding strains in pipe lines, have any tests been made to

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**This discussion was incident to the presentation of this paper before the American Welding Society, Chicago Section, May 4, 1923.*

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show just what effect this preheating has on the structure of the pipe and how far it extends?

A. In welding large pipe in position the contraction as a rule is greater on one side or at some point, which will cause a slight crook in the line; however, the line may look straight but it isn't, this uneven contraction will cause a strain to be left in the weld and by heating a ring around the pipe on either side of the weld will relieve this strain providing the heat is great enough to bring the pipe up to a bending temperature. In all the welding that I have supervised I never did preheat but 3 welds; they were in a 10" ammonia discharge line. There were several more welds in this same line but were not preheated and they have stood up for 2 years so far.

In welding large pipe (or in fact any pipe) a welder should never stop welding a joint until it is completed, the second heat should never be taken on a pipe joint. As this will cause double contraction at this point, the results will be an undue strain unless the second heat is also made on the opposite side of the pipe.

In welding nipples into headers as a rule I make two heats, providing the nipples are to be absolutely straight, that is, weld half way around the nipple, then move back to the first starting point and weld the other half the opposite direction, whereas if the weld is made completely around the nipple and finished at the starting point, there will be two heats at this point causing the nipple to draw out of plumb.

A good thing to keep in mind when welding pipe is to balance the heat in all cases. One great trouble in welding large pipe in position is that the average welder will weld fast on top of a pipe and when he gets to the sides he can't handle the metal as well and he slows up and of course applies more heat at this point. A constant speed should be maintained and never stop a weld unless someone can relieve the welder.

By using these methods, strains in pipe lines, as a rule, don't amount to much.

Q. How much does an engineer in charge of a plant need to know about welding? Do you think he needs to be able to handle the torch himself?

A. An engineer in charge of an ice or cold storage plant which does its own construction work should be a first-class welder, and he can be one if he will only go to the trouble, but at any rate he should know enough about welding to be the engineer on the welding job, just as he is the engineer in directing the men in other departments in the plant. If he can handle a torch and make a first-class weld, so much the better; he can then train his welders to do the work the way it should be done.

An engineer as a rule can train a man in less time than most any one else in the plant as it is a part of his duties to train men to do their work correctly and efficiently.

Q. Can you tell us something about your experience in building up welding organizations? Was it a separate department or were the welders scattered, and how did you go about it to select welders so as to build up a good department?

A. First, I learned to weld myself. I welded specimens and had R. W. Hunt & Co. test them, both for tensile strength and bending. In this way I learned to make 100% welds. The following winter we had about 125,000 ft. of pipe to weld in one plant.

I trained two of our men to weld 1¼" pipe coils for low pressure ammonia. One learned very quickly. I believe I gave him a torch in four days. Out of the first 500 or 600 welds he made there were only 4 or 5 that leaked. When training these men I stay with them every minute of the time until they can make a first-class weld and really know when they are making a good weld and when they are making a defective weld. I would cut out welds on them and have them tested and if they were not 100% I either let them go or put them on other work. When it was necessary to hire four welders later on, I would get two and let them help our old men for two days and as a rule I would spend some time with them the second day and if they were O. K. we gave them a torch the third day, but however we watched them very closely until we were satisfied that they were honest. We hired about thirty men to get the four we wanted. We let them stay from thirty minutes to two days.

Some welders will tell you that they have been welding 15 to 17 years. I had one tell me that he had been welding 15 years and at that time welding had not been introduced into this country but about eleven years; in other words, he was welding four years before we had any equipment to weld with. We did not hire such men. At times the welders were scattered, but we would send the best welders out on work, men that we knew would do the work right. I hired four welders on one job where we made 1,900 welds on 1¼" standard pipe and only had two small leaks, and in both cases the pipe was bad. We made 83 stands of welded ammonia condensers which contained 4,560 welds and only had two small leaks. These coils were tested at 300-lb. air pressure. We have made up any number of double pipe condenser coils and tested at 1,300 to 1,400 pounds and have had no leaks. These coils were welded throughout.

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Position Wanted—First-class electric and acetylene welder with ten years experience in all classes of welding work; five years experience as welding salesman. Will go anywhere, but prefers Chicago. Address, J. I. Mitchell, Elks Club, New Orleans, La.

Position Wanted—Master welder with two years experience as an electric welder and eight years experience as an oxy-acetylene welder. Capable of handling any job—would prefer work with a large concern doing oxy-acetylene welding. Address 77, care The Welding Engineer.

Position Wanted—Electric welder; nine years' experience in electric welding; 2½ years in back shop work; can handle any kind of railroad work but would prefer back shop work. Address 78, care The Welding Engineer.

For Sale—Generators; two (2) 200-pound Davis Pressure Generators and one (1) Master Acetylene Regulator. Good condition. Completion of larger plant necessitates selling. Address Box 1222, Pittsburgh, Pa.

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Of THE WELDING ENGINEER, published monthly, at Chicago, Ill., for April 1, 1923.
State of Illinois, County of Cook, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared L. B. Mackenzie, who, having been duly sworn according to law, deposes and says that he is the Publisher of THE WELDING ENGINEER and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, L. B. Mackenzie, Chicago, Ill. Editor, L. B. Mackenzie, Chicago, Ill. Managing Editor, L. B. Mackenzie, Chicago, Ill. Business Manager, L. B. Mackenzie, Chicago, Ill.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the name and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.) The Welding Engineer, 608 S. Dearborn St., Chicago, Ill. L. B. Mackenzie, 7131 Crandon Ave., Chicago, Ill. M. J. Hungerford, 7131 Crandon Ave., Chicago, Ill.

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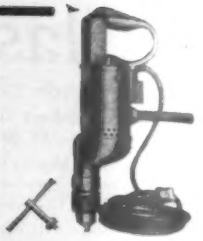

CURRENT WELDING LITERATURE

MECHANICAL GAS CUTTING TORCH AS A LABOR SAVER —It would be easier to mention the locomotive and car repair parts which could not be shaped with the oxy-acetylene cutting torch than to list those which can. The Boston & Maine Railroad secures excellent results on a wide variety of jobs in its repair shops.—Railway Mechanical Engineer, May.

RECENT DEVELOPMENTS IN ARC WELDING, by W. L. Wagner—A summary of research work conducted by the American Bureau of Welding. The report covers standard tests for welds—welding wire specifications—standards for arc welding apparatus—the arc welding of cast iron—specifications for steel to be welded—unfired pressure vessels—welding oil storage tanks—welding rail joints—the applications of welding in railroad shops, locomotive shops, street railways and pipe lines—the welding of monel metal—the manufacture of welding wire—the inspection of welds—the welding of structural steel—welding and ship building —automatic arc welding, and suggestions for further welding research.—Journal of the A. W. S., April.

TRAINING COURSE FOR OXY-ACETYLENE WELDING—Qualifications for welders—fundamentals for gas welding and preliminary practice work. This is the report of the Committee on Training Operators of the American Bureau of Welding. It includes several pages of charts indicating the object of each lesson in the training course and the amount of information necessary to be supplied with each step in the training.—Joural of the A. W. S., April.

THE OXY-ACETYLENE PROCESS IN 1922, by G. O. Carter—Although there are not apt to be any radical changes, there should be room for a growth in the fields where the processes have been successfully applied. Pipe welding is one of the most important applications of the process. The successful handling of maintenance welding has been taken up with the management of many plants, and better provision made for handling this work in the future. Several investigations have been made which promise to extend the application of oxy-acetylene cutting. The use of the cutting process on cast iron is developing slowly. The possibilities of welding tanks are becoming more and more interesting.—Journal of the A. W. S., April.

MALLEABLE IRON, by M. LeGrix—A study of the composition of malleable castings and the changes which they undergo when raised to high temperatures. Comparisons are made between European and American malleable castings. It is shown that although they are given, apparently, the same treatment, they show an entirely different grain structure under the microscope.—Revue de La Soudure Autogene, Paris, April.

THE PROCESS OF WELDING WITH THE OXY-BENZOL FLAME—Although this process is being used considerably in France, the writer claims that in no case, even for very thin sheets, is the oxy-benzol weld able to compete with the oxy-acetylene weld.—Revue de La Soudure Autogene, Paris, April.

REPAIR OF DIES BY WELDING, by A. M. Candy—Arc process used on flanging dies and plate shear blades. Substantial economies claimed. All of this work is performed by the metallic electrode process, using a special high carbon welding wire, 1% carbon and .6% manganese.—Iron Age, April 12th.

AUTOGENOUS WELDING IN THE PETROLEUM INDUSTRY, by K. V. King—A discussion of the welding performed by the Standard Oil Company of California. Welding is finding its greatest field of usefulness in the refineries, although it is used extensively in pipe lines and in boiler making, as well as in pressure still construction. This company has never had an accident or failure due to defective autogenous welding.—Acetylene Journal, May.

THE BUSINESS MAN'S INTEREST IN THE OXY-ACETYLENE PROCESS, by G. O. Carter—A survey of the economies which can be obtained by the application of the oxy-acetylene cutting and welding processes. Discussion of the value of the oxy-acetylene torch for both production and reclamation. Growing field of usefulness for pipe welding and tank welding.—Acetylene Journal, May.

HOW WELDED JOINTS SOLVE PIPE LINE TROUBLES—Forty-page booklet published by the Oxweld Acetylene Co., Newark, N. J., containing a series of articles which show how the oxy-acetylene process has been used to advantage in welding all kinds of pipe lines. Booklet contains many instructive illustratios of pipe welding.

THE METALLURGICAL ASPECTS OF WELDING—The beneficial effect of heating the material to a temperature of 900° C. and allowing it to cool regularly. Failure to make an actual joining of the parts to be welded is usually due to the presence of oxides in the weld. Other failures are due to attempts to weld alloy steel which cannot be successfully welded.—Actylene and Welding Journal, London, April.

SOME RECENT DEVELOPMENTS AND USES FOR RESISTANCE WELDING, by H. A. Woofter—There has been considerabe work done in seam welding in the last few years. Spot welders are now being designed which will be entirely automatic as regards time and pressure so that all welds will be made alike. By some of the resistance welding processes nearly all metals and alloys can now be welded.—American Machinist, April 26th.

ELECTRIC ARC WELDING OF THIN SHEET METAL, by H. E. Wagner—Thin sheet welding was at one time considered very difficult. The first solution of the problem was to upturn the edges of the sheet and make a weld with a carbon electrode. Hand and machine welding can be done at varying speeds, depending upon the ability of the operator. Men trained in the welding of thin metal do not usually work successfully on thick material. Very thin sheet plates are now welded by the electric resistance methods.—Railway Electrical Engineer, April.

THE SIDE LINE IN PRODUCTION WELDING—Production welders in a large plant are kept busy in the off-seasons adding other sheet metal products to the line.—Oxy-Acetylene Tips, April.

A THOUSAND DIFFERENT PARTS WELDED IN ONE SHOP —One of the country's largest aeroplane manufacturers has a completely equipped central welding shop where more than one thousand different parts are fabricated by the oxy-acetylene process. For this work welding operators must be well trained and know the exact welding requirements for each part. It has been the experience of this company that better work has been obtained by having a carefully organized welding department.—Oxy-Acetylene Tips, April.

FABRICATING STORAGE TANKS BY OXY-ACETYLENE WELDING—Methods employed by one producer of gasolene storage stanks to increase the economy of operation in his plant. Rectangular method of construction—layout of welding shop. Procedure followed in the fabrication of large tanks.—Boiler Maker, April.

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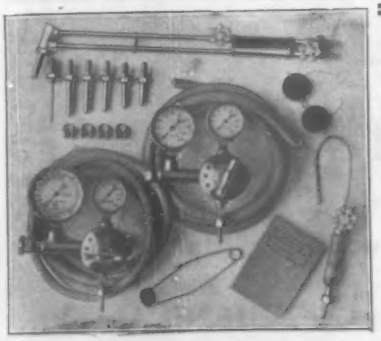

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Approximating
3.00%—in Silicon (Result: A soft weld)
.60%—in Phosphorus (Result: Fluidity)
.02%—in Sulphur (Result: A clean weld)

Our Rods the Best by Test. Also Rods, Wires and Fluxes for Welding All Other Metals

Prices on Application

Bierman-Everett Foundry Co.,
133-153 So. 20th St., Irvington, N. J.

OXYGEN
FOR CUTTING, WELDING, ETC.

Quick shipment and low prices on oxygen, hydrogen, cylinders, valves, welding and cutting torches, regulators, welding wire, cast iron and aluminum rods, fluxes, plain and armored rubber hose, asbestos pads and paper, goggles, etc. All equipment fully guaranteed.

We are the American pioneer manufacturers of oxygen. Write for catalog and prices.

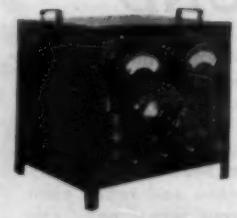
International Oxygen Company
Main Offices: NEWARK, N. J.
Branch Offices: New York, Pittsburgh, Toledo.

Specify—
"MOREY"

A Moisture Proof Aluminum Flux
Stable, Economical, Marvelous

MOREY FLUX & CHEMICAL CO.
Parkesburg, Penna. U. S. A.
Est. 1912 Inc. 1915

QUASI-ARC SYSTEM

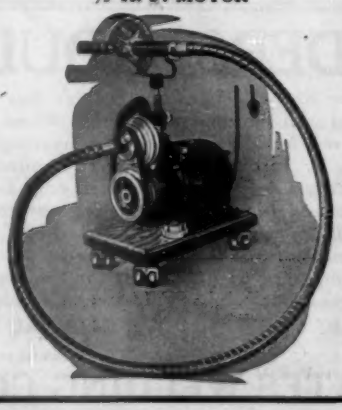


We Manufacture:
A. C. & D. C. Welding Sets
Also Weldtrodes for
Mild Steel
High Carbon
Manganese
Cast Iron

L. W. 110 V. WELDER
Gives Machinable Weld

QUASI-ARC WELDTRODE CO., INC.
Peekskill, New York

TYPE M6
½ H. P. MOTOR



Strand
Trade Mark
GRIND Those Welds With
STRAND
Flexible Shaft Grinders
Thousands in Use
N. A. Strand Co.
CHICAGO
THE ELECTRICAL BLDG.
625 W. Jackson Blvd.

Westinghouse
manufactures complete arc welding equipment for all welding and cutting purposes. Write for Leaflet 1826-B which describes this equipment in detail.
Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.

DAVIS-BOURNONVILLE COMPANY
was merged with
AIR REDUCTION SALES COMPANY
on March 17, 1922

The Oxyacetylene Welding and Cutting products formerly manufactured by Davis-Bournonville Co. are now made and sold by Air Reduction Sales Co. under the trade name of "Airco-Davis-Bournonville" or "Airco-D-B."

(See advertisement of Air Reduction Sales Co.)

IMPERIAL WELDING AND CUTTING EQUIPMENT
OXY-ACETYLENE PROCESS

A new mixing principle, a regulator that accurately controls gases, the greatest working range ever covered by ONE torch—are exclusive IMPERIAL features. Write for catalog.
Imperial Brass Mfg. Co., 517 S. Racine Ave., Chicago

For Gases Charged at High Pressures
WM. WHARTON, JR. & CO., INC.
30 Church St., New York, N. Y.

Carbic

ONLY THREE PARTS

See how quickly and easily the Carbic Generator is charged. There are no complicated and intricate parts. A water tank, a gas bell and cake holder which cannot be wrongly assembled. That's Carbic simplicity.

The Carbic Generator, altho entirely different from all others, is not an experiment. Under most severe tests and constant usage this generator has repeatedly demonstrated its many merits and advantages and has proven by its extensive use in steel mills, foundries, repair shops, industrial plants, etc., that it embodies the combined features of efficiency, portability and economy to a degree never before approached.

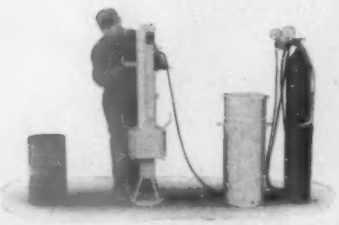
Consider the Carbic System for your own work.

Catalogs and complete information on request. Write for them.

The Carbic Line is complete, including generators, torches, regulators and all other necessary apparatus and supplies.

Fill Tank With Water to Lower Line.

Insert the Carbic Cakes in Cake Holder.



Place Gas Bell over Cake Holder and Swing in Rod Supports.

Lower Gas Bell into Tank.

Carbic Manufacturing Company

Duluth, Minnesota

Sales Offices:

NEW YORK, 141 Centre Street

CHICAGO, 565 W. Washington Blvd.

BOSTON, 27 School Street

Representatives and Stocks in all Principal Cities.

Carbic Cakes save money, time and patience, and yield a purer gas.

The Sensation of the Welding Trade

SAFETY FIRST

for

Oxy-Acetylene Welding and Cutting

THE MATTINGLY SAFETY VALVE closes Automatically and Instantly to stop the escape of Gas from the Tank should the Hose Line fail from any cause and thereby prevents Personal Injuries, Fires, Explosions, Loss of Gas and Burned Hose. It minimizes all dangers incident to flash-back and back-fire and fills a long felt want for a **SAFETY DEVICE** to be used in connection with the Oxy-Acetylene Welding & Cutting Apparatus.

This **SAFETY DEVICE** works equally well with any make of regulator and does not interfere with the operation of the Torch. The illustration shows a typical installation.

MATTINGLY SAFETY VALVES are now being used by hundreds of Railroads, Street Railways, Steel Mills, Gas Plants, Car Manufacturers, Water Works, Light Plants, Coal Mines, Foundries, Garages, Ship Yards, Dry Docks, Coal Mines, Boiler Manufacturers, Tank Car Lines, Pipe Lines, Sheet Metal & Iron Works and in fact all lines of industry that use Oxy-Acetylene Welding & Cutting Equipment.

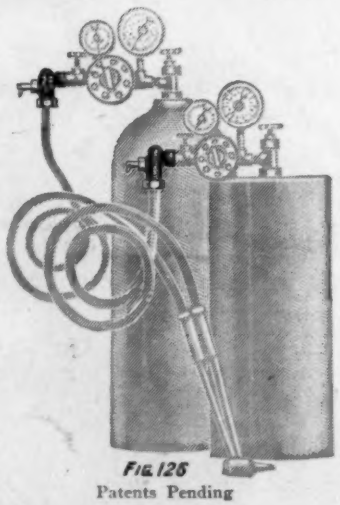


FIG. 126

Patents Pending

MATTINGLY
SAFETY VALVES
Are Giving
Dependable Service
in
UNITED STATES
NAVY YARDS

This **SAFETY DEVICE** is sold **ONLY** on its merits and may be had by any responsible party on 30 days trial with the understanding that the same is to be returned if not satisfactory.

PRICE: $10.00 Per Pair, Delivered, U.S.A.

Made to fit any make of Regulator. **Do not fail to give size of the Hose Connection at the Regulator when ordering.** Complete instructions for care and operation are furnished with every pair of valves.

If you are interested in SAFER Welding and Cutting, we solicit your TRIAL ORDER on the above basis.

Yours for SAFER Welding

MATTINGLY AUTOMATIC VALVE CO.

Nineteenth and Olive Streets St. Louis, Mo.